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Terms	Documents
L10 and L9	86

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DATE: Tuesday, June 25, 2002 Printable Copy Create Case

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L11	L10 and L9	86	L11
L10	(chang$3 or updat$3 or upgrad$3) near (map or image or display)	47781	L10
L9	L8 and L7	235	L9
L8	(new or chang$3 or updat$3 or upgrad$3) near (position or location or node or landmark or point)	171300	L8
L7	L6 and L1 and L3 and L4 and L5	528	L7
L6	L2 and display	12062	L6
L5	destination	127695	L5
L4	start$3 near (position or location or point or landmark or node)	161578	L4
L3	(current or present) near (position or location)	35994	L3
L2	map and L1	17099	L2
L1	navigation or gps	406180	L1

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L11: Entry 52 of 86 File: USPT Jun 30, 1998

DOCUMENT-IDENTIFIER: US 5774828 A
TITLE: Mapless GPS navigation system with user modifiable data base

Abstract Paragraph Left (1):
A navigation system is provided for offering navigational assistance to a mobile user. The navigation system receives GPS position information signals which are processed to determine current position latitude and longitude coordinates and direction of travel. A destination database includes a plurality of categorized destinations and corresponding destination position coordinates pertaining to the destinations. The destination database is stored on an interfacable memory card and contains menu categories and subcategories for classifying the destinations and additional text information pertaining to the destinations. User selectable menu controls enable the user to sequence through the menu of categories and destinations and select a desired destination. This is easily accomplished by rotating a rotary pushbutton to view category and destination selections and depressing the rotary pushbutton to select the selection shown. A processor compares the current position coordinates with the position coordinates of the selected destination and determines a distance and a straight-line direction from the current position to the selected destination. A display displays the distance and a direction pointing indicator for showing the direction from the current position to the selected destination. In one embodiment, the navigation system is integrated with an audio entertainment system and shares a common display and housing.

Brief Summary Paragraph Right (2):
This invention relates generally to navigation systems and, more particularly, to an easy to use direction pointing navigation system and method employing global positioning system signals and a user modifiable destination database.

Brief Summary Paragraph Right (4):
The concepts of intelligent vehicle highway systems (IVHS) are changing the future of ground transportation systems. In particular, navigation systems have been developed and are increasingly becoming available for use in assisting a mobile user. For example, on-board navigation systems are currently provided in some automotive vehicles to assist the driver of the vehicle in navigating the vehicle along a route or roadway system to reach a desired destination.

Brief Summary Paragraph Right (5):
Early navigation systems generally did not have the availability of advanced positioning systems such as global positioning system (GPS). Instead, a number of early navigation systems often relied exclusively on dead reckoning techniques to account for a moving vehicle's location. Generally speaking, dead reckoning is the determination of position by advancing a known position using measured courses and distances. This generally involved determining a starting location and manually setting the vehicle's position on an electronic map. With the use of a dead reckoning technique, an approximate path of travel of the vehicle could be computed and updated as the vehicle was driven. The travel path determination was often achieved by way of a compass reading and vehicle speed information or was achieved by some other kind of dead reckoning technique. However, many of the dead reckoning based navigation systems often failed to provide accurate and continuous navigation assistance and therefore required repeated corrections to the vehicle's computed position.

Brief Summary Paragraph Right (6):

The development of the global positioning system (GPS) by the United States Department of Defense has greatly enhanced the ability to navigate. Currently, a constellation of satellites are in place orbiting the earth at high altitudes and transmitting radio waves which contain position information. With the use of GPS receivers, the position information can be received and used to calculate the current latitude and longitude position coordinates at the receiving location. The global positioning system is currently achieving recognition as the superior position locator system for providing accurate worldwide fixes.

Brief Summary Paragraph Right (7):
With the widespread availability of GPS, more recent navigation systems now rely on GPS to provide position information to compute a vehicle's position. According to one approach, the computed position of the vehicle is contrasted to a digitized map. This technique, also known as map matching, requires a complex digitized map data base and normally uses an expensive full function detailed map display to show the digitized map in relation to the vehicle's position. The digitized map data base has to consider one-way street information, turn restrictions and other roadway requirements. Often with the use of a complex algorithm, a computer would attempt to compute a best route from the vehicle's current position to a desired destination, considering all available street changes and travel restrictions. This results in turn-by-turn instructions in which a driver is instructed to turn left or right or proceed straight ahead on each approaching street.

Brief Summary Paragraph Right (8):
The use of map matching navigation and other similar full function navigation systems has generally provided a user with the ability to follow calculated turn-by-turn instructions as computed by the navigation system. However, map matching techniques generally do not take into consideration changes in travel routes and roadway restrictions. That is, changes in a transportation system which often occur, especially on roads subjected to road construction, remain unaccounted for. Also, some drivers may feel that the expensive full function displays may tend to cause the driver to rely too heavily on the map display for driving instructions rather than for mere assistance. They therefore may feel that such displays are too distractive. Furthermore, most full function navigation systems are commercially available at a very high cost which often makes the systems unaffordable to a vast majority of consumers.

Brief Summary Paragraph Right (9):
Additionally, vehicle navigation systems in the past have generally been limited to the predefined mapping and destination information loaded into nonprogrammable memory. Accordingly, the user is generally limited to the information initially provided therewith. Given this limitation, the user is unable to store desired destinations and to modify the available destination data base to account for additional destinations of interest. Flexible programmability may be desirable to expand the use of the navigation system.

Brief Summary Paragraph Right (10):
It is therefore desirable to provide a low cost and easy-to-use navigation system which offers flexible navigational assistance to a mobile user for traveling to desired destinations.

Brief Summary Paragraph Right (11):
More particularly, it is also desirable to provide such a navigation system which offers programmability to a user so that a desired destination may be user programmed and later recalled.

Brief Summary Paragraph Right (12):
It is also desirable to provide a user modifiable navigation system that employs global positioning system signals and destination data base and provides destination direction pointing assistance in a manner which is affordable to many users.

Brief Summary Paragraph Right (13):
It is further desirable to provide such a programmable navigation system which may easily be integrated into an audio entertainment system and installed in an automotive vehicle for use in assisting the driver of the vehicle to reach a desired destination.

Brief Summary Paragraph Right (14):
Yet, it is also desirable to provide such a navigation system which is capable of retrieving categorized destinations from a remote memory and storing the destination in a local modifiable data base.

Brief Summary Paragraph Right (15):
In accordance with the teachings of the present invention, a navigation system and method are provided for offering navigational assistance to a mobile user. The navigation system includes a GPS position sensing receiver for receiving GPS position information signals. The GPS position information signals are processed to determine current latitude and longitude position coordinates. The navigation system has a readable destination database containing a plurality of categorized destinations and corresponding latitude and longitude position coordinates pertaining to the destinations. The navigation system also includes a user modifiable data. A user may program the user modifiable data base to save a current position to be recalled from memory at a later time. User selectable menu controls are provided to sequence through and select a destination. A processor receives the current position coordinates and the selected destination coordinates and determines a straight-line direction and distance from the current position to the selected destination. The navigation system further includes a display which displays the distance and a direction pointing indicator for indicating the direction from the current position to the selected destination.

Brief Summary Paragraph Table (1):
U.S. Ser. No. Title
08/418,931 LOW COST NAVIGATION SYSTEM R. Brunts WITH DESTINATION DATA BASE A. Ramaswamy D. Welk 08/418,933 MAPLESS GPS NAVIGATION SYSTEM A. Ramaswamy IN VEHICLE ENTERTAINMENT SYSTEM R. Brunts 08/418,932 MAPLESS GPS NAVIGATION SYSTEM WITH R. Brunts RADIALLY SORTABLE DESTINATIONS D. Welk 08/418,934 MAPLESS GPS NAVIGATION SYSTEM R. Brunts WITH ROTARY PUSH BUTTON USE D. Welk INTERFACE CONTROL 08/418,809 PCMCIA CARDS AS REPLACEABLE A. Ramaswamy MEMORY IN GPS NAVIGATION SYSTEM D. Welk R. Brunts

Drawing Description Paragraph Right (2):
FIG. 1 is a front view of a navigation system packaged by itself according to one embodiment of the present invention;

Drawing Description Paragraph Right (3):
FIG. 2 is a front view of the navigation system integrated with an audio entertainment system in accordance with another embodiment of the present invention;

Drawing Description Paragraph Right (6):
FIG. 5 is a view of an automotive vehicle equipped with the navigation system of the present invention;

Drawing Description Paragraph Right (7):
FIG. 6 is a schematic view of the display graphics employed by the navigation system of the present invention;

Drawing Description Paragraph Right (8):
FIG. 7 is a perspective view of a head-up-display which may be employed to supplement the display of FIG. 6 according to an alternate embodiment;

Drawing Description Paragraph Right (9):
FIG. 8 illustrates a readable PCMCIA standard memory card which contains categorized destinations and destination information in a data base;

Drawing Description Paragraph Right (10):
FIG. 9 illustrates categories, categorized destinations and destination information contained in the data base that is stored on the memory card of FIG. 8;

Drawing Description Paragraph Right (11):
FIG. 10 illustrates menu selections which are available with the navigation system

according to one example;

Drawing Description Paragraph Right (13):
FIG. 12 illustrates the use of the navigation system for assisting a driver of a vehicle to reach a selected destination according to one example;

Drawing Description Paragraph Right (14):
FIG. 13 is a flow diagram illustrating a methodology of providing position updates with the navigation system of the present invention;

Drawing Description Paragraph Right (15):
FIGS. 14A through 14C illustrate a sequencing of menu selections and displays when selecting a destination and destination information from the memory card destination data base; FIG. 14A shows selection of a fast food destination; FIG. 14B further shows selection of a fast food destination from a group of same name destinations; and FIG. 14C illustrates the menu selection sequencing and displays with a sort by distance operation;

Drawing Description Paragraph Right (16):
FIG. 15 illustrates a sequencing of menu selections and displays when entering a destination by latitude and longitude position coordinates in the latitude/longitude menu mode; and

Drawing Description Paragraph Right (17):
FIGS. 16A through 16E illustrate sequencing of menu selections and displays when saving and recalling stored destinations and information in a user programmable memory when in the save/recall menu mode; FIG. 16A illustrates saving the current position as a destination; FIG. 16B illustrates saving the last selected data base destination; FIG. 16C illustrates saving a destination from the latitude/longitude menu mode; FIG. 16D illustrates recalling user stored destinations which were stored from the data base; and FIG. 16E illustrates recalling user stored destinations which were stored as latitude/longitude position coordinates.

Detailed Description Paragraph Right (1):
Turning now to FIGS. 1 and 2, a mapless navigation system is shown according to two embodiments 10A and 10B of the present invention for providing navigation services. The navigation system 10A of FIG. 1 is configured as a stand-alone navigation unit. The navigation system 10B of FIG. 2 is integrated into an audio entertainment system of the type generally configured for installation in an automotive vehicle. Both embodiments of the navigation system 10A and 10B contain similar navigation related components and provide the same or substantially similar navigation services. Accordingly, the navigation system is often generally referred to herein as reference numeral 10. Like components in both system embodiments of 10A and 10B share like reference numerals.

Detailed Description Paragraph Right (2):
Referring particularly to FIG. 1, the stand-alone navigation system 10A has a face plate 12A assembled on the front side of a generally rectangular housing. The housing may include two side mount brackets (not shown) integral to housing and a rear mounted stud (also not shown) for mounting to a supportive structure. For automotive vehicle use, the housing is preferably mounted or integrated within the instrument panel (IP) of an automotive vehicle in a manner similar to the mounting of a car radio. However, the stand-alone navigation system 10A could be employed as a portable hand-held navigation unit and used for a wide variety of navigational applications.

Detailed Description Paragraph Right (3):
Extending from the face plate 12A of navigation system 10A are several manually selectable controls for controlling various navigational functions. Included is an "ON/OFF" pushbutton control 14, a "MENU CHOICES" rotary/pushbutton control 16, a navigation menu selection "NAV MENU" pushbutton 18, an "UNDO" selection pushbutton 22, an information "I" pushbutton 20, a sort by distance "SORT" pushbutton 24, a current position "POS" pushbutton 26 and a direction heading pushbutton 28.

Detailed Description Paragraph Right (4):
The navigation menu selection pushbutton 18, when manually depressed, displays the

navigation main menu. The navigation main menu contains three navigation menus, namely, a destination menu, a latitude/longitude menu, and a save/recall menu. The menu choices rotary/pushbutton 16 is rotatable to switch between various selections of a selected navigation menu and depressible to select the option that is currently displayed. The undo pushbutton 22 will undo the last selection and return to the previous selection. Repeatedly pressing the undo pushbutton 22 will continue to undo the previous selections until the display 30 returns to the main navigation menu. The information pushbutton 20 will retrieve alphanumeric text information pertaining to a selected destination. The sort by distance pushbutton 24 initiates a sorting function for sorting destinations based on distance from a particular location. The position pushbutton 26 displays the current latitude and longitude position coordinates, while direction heading pushbutton 28 provides the current vehicle direction heading.

Detailed Description Paragraph Right (5):
The navigation system 10A includes a navigation guidance display 30 for displaying a direction pointing arrow 32 and alphanumeric text 34. The direction pointing arrow 32 points in the straight-line direction toward a selected destination. The alphanumeric text 34 may include various destination names, distances, menu selection names, latitude and longitude position coordinates, current direction heading readings, time of day and other alphanumeric text information. After a specific destination is selected, the text information 34 may include the name of the selected destination and the straight-line distance from the current position of the navigation system 10A to the selected destination. The direction pointing arrow 32 and distance readings are continually updated in response to sensed GPS signals and can be maintained when GPS is unavailable with the use of a back-up dead reckoning technique.

Detailed Description Paragraph Right (6):
Because the number of predetermined destinations can be enormous, we prefer to group selected types of destinations into separate data bases and to store each data base on a separate readable memory card. Hence, only small data bases need be used. This feature of the invention permits use of a wide variety in types of destination groupings, as will hereinafter be explained. The memory card is about the size of a credit-card and is preferably formatted to PCMCIA standards. Use of PCMCIA standard connections to the card not only help maintain low cost but also provides other advantages which also will hereinafter be explained.

Detailed Description Paragraph Right (7):
To accommodate a large number of destinations, a plurality of memory cards are made available to select from. Each memory card would contain a selected type of data base as for example a camping information directory, a business directory, a restaurant/hotel directory, etc. for covering a given geographic area. Each memory card provides categorized destinations with corresponding latitude and longitude position coordinates within a predefined territory and also includes alphanumeric text information pertaining to each of the destinations. For example, a business directory data base may provide business names, address locations, phone numbers and business operating hours, as well as other types of information.

Detailed Description Paragraph Right (8):
To access the destination information, the navigation system 10A is equipped with a memory card interface 36. With the appropriate memory card inserted in memory card interface 36, thousands of destinations are available for exploration. Since the PCMCIA memory cards are relatively small and of a standard interface type, their cost is minimized. Also, the PCMCIA memory card is small enough to allow one to carry a plurality of cards in a vehicle without an undue burden. Still further, the PCMCIA memory card could be readable by an ordinary computer having a compatible program, and thus given it an alternate use for accessing information on computers which are compatible with the PCMCIA standard memory card.

Detailed Description Paragraph Right (9):
Businesses with many outlets, offices or affiliates may find it economically worthwhile to compile data bases that include and/or favor themselves, and to distribute such data bases on PCMCIA memory cards to potential customers at no or low cost. For example, a golf organization may find it advantageous to distribute PCMCIA memory cards equipped with a desired data bases to its members and potential members or customers. Such a marketing strategy will enable the card holder to navigate to

destinations affiliated with the organization.

Detailed Description Paragraph Right (10):
Still further, the PCMCIA memory card could be made with programmable memory that is inherently nonvolatile or that has a battery back-up on the card. Such a memory card is more expensive but would offer added flexibility in programming. A user could therefore save destination-related information on such a programmable memory card. One could even program such a programmable PCMCIA card with selected destinations on one's personal computer and then use the PCMCIA memory card in a navigation system such as that described herein. A patent application on such a programmable memory card is expected to be filed.

Detailed Description Paragraph Right (11):
Accordingly, use of the PCMCIA memory card for replaceable memory in this invention opens up a myriad of possibilities for types of data bases that might be stored on them for use in the navigation system 10 of this invention.

Detailed Description Paragraph Right (12):
With particular reference to FIG. 2, the navigation system 10B is integrally packaged with an audio entertainment system and contains substantially the same navigation components and features provided in the standalone navigation system 10A. The navigation/audio entertainment system 10B has a face plate 12B which likewise includes the "MENU CHOICES" rotary/pushbutton 16, navigation menu "NAV MENU" pushbutton 18, information "I" pushbutton 20, "UNDO" pushbutton 22, sort by distance "SORT" pushbutton 24, position "POS" pushbutton 26 and current direction heading pushbutton 28. The integrated navigation/audio entertainment system 10B similarly has a guidance display 30 that is commonly shared among the navigation, audio radio and audio cassette tape modes of operation. That is, display 30 will provide the direction indicating arrow 32 with the destination information 34 when in the navigation display mode. However, display 30, when in the audio radio display mode, will generally display AM or FM frequency selections in addition to the time of day and various types of radio related information. When in the audio cassette tape display mode, the display 30 will display information pertaining to the cassette tape operation.

Detailed Description Paragraph Right (15):
While the preferred embodiment of the navigation/audio entertainment system 10B includes an AM/FM radio and audio cassette tape player integrated with the navigation system in FIG. 2, it should be appreciated that other audio entertainment systems or combinations of audio systems may be combined with the navigation system. For example, an audio compact disc (CD) player could be employed in addition to or in place of the audio cassette tape player 46. Alternately, an externally located compact disc (CD) changer could be electrically coupled to the radio tuner and operated in conjunction with the radio. It is also conceivable that destination-related information could be stored on and retrieved from a compact disc or cassette.

Detailed Description Paragraph Right (16):
Referring to FIGS. 3 and 4, the navigation/audio entertainment system 10B is further shown to include various interconnected electronics and processing components and signal inputs. As mentioned above, the face plate 12B encompasses shared display 30 and the various user controls as represented by key matrix 60. The housing of system 10B is generally represented by reference numeral 61. Packaged within housing 61 is the audio cassette tape player 46, memory card interface 36, a radio control board 62 and a navigation board 68. The radio control board 62 is connected to a radio tuner 64 and the audio cassette tape player 46. The radio tuner 64 is further coupled to an externally located radio antenna 66 for receiving radio wave signals. In addition, audio speakers 65 are generally coupled to the radio control board 62.

Detailed Description Paragraph Right (17):
The radio control board 62 communicates with the navigation board 68 via an array of communication lines including SPI and WAKEUP lines. The navigation board 68 is connected to the memory card interface 36 and a GPS receiver 70. The GPS receiver 70, in turn, is connected to a GPS antenna 72. According to well known GPS operations, the GPS receiver 70 receives GPS radio wave signals which are emitted from existing GPS satellites and received via the GPS receiving antenna 72. Currently, a constellation of high altitude GPS satellites are in orbit and available to provide continuous

worldwide position fixes in all types of weather conditions. The GPS receiver 70 has a built-in processing unit and memory for processing the GPS radio wave signals to determine the latitude and longitude coordinates of the current position, as well as determining the current direction of travel.

Detailed Description Paragraph Right (18):
More specifically, the GPS receiver 70 continuously receives radio wave signals from the GPS antenna 72 and determines accurate position coordinates which identify the location of the received signals. This determination includes calculating the distance from various satellites to determine a location relative thereto. By measuring the current signals sent by the GPS satellites and knowing orbital parameters of the satellites, the GPS receiver 70 is able to determine the location thereof and generate longitude and latitude position coordinates identifying the position of the received signals.

Detailed Description Paragraph Right (19):
More particularly, with the received GPS signals, the latitude and longitude position coordinates of the GPS receiver 70 are determined by computing distance from each of several GPS satellites currently visible to the receiver 70 by direct line-of-sight. Distance is determined by precise computation of the time required for radio signals to travel from the GPS satellite to the GPS receiver 70. Combined with precise information about the satellites'positions relative to the earth, precise latitude and longitude coordinates are computed.

Detailed Description Paragraph Right (20):
At speeds greater than a few miles per mile, the GPS receiver 70 can also determine a precise direction of travel. The receiver 70 determines rate of change in range or relative speed to each visible satellite. Combined with precise knowledge of satellite orbits and the earth's rotation, the ground velocity (i.e., speed and direction) of the GPS receiver 70 can be precisely determined. The determined direction heading is preferably used as a reference while the vehicle is moving at a speed of greater than five miles per hour, for example.

Detailed Description Paragraph Right (21):
GPS is widely known and should be understood to those skilled in the art as a means for providing accurate position location information with an accuracy within one-hundred (100) meters or better for over ninety-five percent (95%) of the time. It should also be understood that enhanced accuracy may be obtained with GPS now and in the future. For example, a differential receiver could also be employed to provide the availability of differential GPS which offers enhanced position determining accuracy.

Detailed Description Paragraph Right (22):
The navigation board 68 receives a number of signal inputs which include a signal indicative of the vehicle direction heading as generated by a magnetic flux gate compass 74 according to one embodiment. According to a second embodiment, the direction heading signal may alternately be generated with a gyro compass. The gyro compass offers the advantage of immunity to magnetic noise such as is common in urban environments and near power distribution centers. Accordingly, the gyro compass may be more desirable when GPS blockages combined with high magnetic noise levels can be expected. The direction heading indication provided by compass 74 is used as backup heading information which serves as a reference for determining straight-line direction to a selected destination when the vehicle's speed drops below five miles per hour. The direction heading signal from compass 74 is also is used with the back-up dead reckoning system when GPS is unavailable.

Detailed Description Paragraph Right (23):
Additionally, a vehicle speed sensor(VSS) signal 76 is received by the navigation board 68 to provide an indication of vehicle speed. Also received by the navigation board 68 is a transmission position (PRNDL) signal 78 which provides an indication of a forward or reverse direction of travel of the vehicle. Together, the direction heading signal provided by a compass 74, as well as the vehicle speed sensor signal 76 and transmission position signal 78 allow for the backup dead-reckoning system to complement the GPS position coordinates.

Detailed Description Paragraph Right (25):

The navigation board 68 also contains its own navigation control microprocessor 92 for controlling the primary navigation functions of the present invention. The microprocessor 92 has built-in random access memory (RAM), electronically erasable programmable memory (EEPROM) 98, read only memory (ROM) 100, a serial input/output 102 and an input/output 104. The EEPROM 98 and ROM 100 generally contain the necessary programmed instructions for performing the primary calculations to determine distance and direction to selected destinations. Also included on the navigation board 68 is random access memory (RAM) 94 and the memory card interface 36. The random access memory (RAM) 96 or 94 preferably contains programmable memory locations for storing destination information and for continually storing variables used to determine the direction and distance information as processed by the navigation control microprocessor 92.

Detailed Description Paragraph Right (26):
The GPS receiver 70 also includes a built-in GPS control microprocessor 106 and random access memory (RAM) 108. Microprocessor 106 also contains built-in random access memory (RAM) 107. The random access memory (RAM) 107 or 108 preferably stores the radio wave signals received from the GPS receiving antenna 72 for processing. The GPS control microprocessor 106 processes the received radio wave signals and calculates the current latitude and longitude position coordinates thereof in addition to calculating the current direction of travel. The calculated position coordinates and direction data may thereafter be stored in RAM 107 or 108.

Detailed Description Paragraph Right (27):
According to a preferred embodiment, the navigation system 10 may easily be mounted in an automotive vehicle 110 as shown in FIG. 5. According to the automotive vehicle application, the navigation system 10 may easily be mounted within the dash of the vehicle 110 in a manner similar to the mounting of a car radio. Accordingly, the key matrix 60 and display 30 are easily accessible by the driver or a passenger in the vehicle 110. The magnetic flux compass 74 is located near the upper midportion of the windshield near or within the rearview mirror assembly. The vehicle speed sensor (VSS) signal 76 and transmission position (PRNDL) signal 78 are taken from the vehicle transmission. The GPS antenna 72 is preferably mounted on the roof of the vehicle 110 and exposed to GPS radio wave signals.

Detailed Description Paragraph Right (28):
With particular reference to FIG. 6, the display 30 is shown in an enlarged schematic view. The display 30 is a simplistic and inexpensive alphanumeric text with direction pointing arrow display. According to one embodiment, display 30 is a vacuum fluorescent (VF) display. Alternately, display 30 may include a liquid crystal display (LCD) equipped with back-lighting. Other similar simplistic and inexpensive displays which can produce a variable straight-line direction pointing arrow or the like and alphanumeric text can alternately be employed.

Detailed Description Paragraph Right (29):
The display 30 shown includes a direction pointing arrow display 112 containing a plurality of equiangular direction pointing arrows such as arrow 32. According to the embodiment shown, direction pointing display 112 includes sixteen possible arrow selections equi-angularly displaced 22.5.degree. about a 360.degree. rotation. The appropriate direction pointing arrow such as arrow 32 is selected and actively displayed as a darkened arrow to provide an indication of the straight-line direction from the current position of the GPS receiver 70 to a selected destination. The arrow direction may vary and is determined by the calculated direction as referenced to the current vehicle heading provided by the GPS receiver 70 or backup compass 74. The direction pointing arrow 32 pointing upward indicates that the destination is directly ahead of the vehicle, while the direction pointing arrow 32 pointing downward indicates that the destination is directly behind the vehicle. The direction pointing arrow 32 pointing to the right indicates that the destination is to the right and that the driver of the vehicle may turn the vehicle when appropriate. Likewise, the direction pointing arrow 32 pointing to the left indicates that the destination is to the left.

Detailed Description Paragraph Right (30):
The navigation display 30 further includes alphanumeric character displays 114 for displaying alphanumeric characters. Character displays 114 each preferably include an

array of segments, pixels or a dot matrix for economically displaying alphanumeric characters such as individual alphabetical, numeric or other symbolic characters. The display 30 is equipped with a limited number of character displays 114. As shown, a total of twenty-four character displays 114 are divided between a top line and a bottom line of text. The text information 34 may include various menu categories, sub-categories, destinations, distance information, and a wide variety of alphabetical, numerical and text information. As shown in FIG. 6, a destination name 116 is provided on the top line. Displayed on the bottom line is a distance as determined from the current position to the selected destination. While the distance shown is displayed in miles, the metric equivalent of the distance in kilometers (km) could likewise alternately be displayed.

Detailed Description Paragraph Right (31):
The navigation system 10 of the present invention may further employ a head-up-display 148 as shown in FIG. 7. The head-up-display 148 provides an easy to view image of the vehicle speed looking through the front windshield when driving a vehicle. The head-up-display 148 may further show the straight-line direction pointing arrow 32 and distance information 118 as a complement to the display 30. The added use of the head-up-display 148 allows for easy viewing of the direction and distance so the vehicle driver can easily view the continuously updated navigation information while driving the vehicle.

Detailed Description Paragraph Right (32):
Referring to FIG. 8, a preferred memory card 120 that is used to provide a categorized destination data base is shown therein. According to one embodiment, the memory card 120 is formatted to PCMCIA standards and contains selectable destinations in a categorized business directory data base that is stored on read only memory (ROM) within the memory card 120. One example of the PCMCIA memory card 120 is Model No. FE02M-20-10038-01manufactured and sold by Centennial Technologies, Inc. This particular memory card 120 has a PCMCIA standard interface which includes a total of sixty-four female electrical connector holes 122 provided at the connector end for receiving pin connectors within the memory card interface 36. It should be appreciated that a plurality of memory cards 120 may be selected from to view desired destinations and destination-related information made available for a predefined geographic territory. By inserting the appropriate metropolitan area memory card into the memory card interface 36, thousands of destinations become available for exploration by a user. In doing so, a user may select from the various categories and sub-categories to find a desired destination from the destination database on the memory card 120.

Detailed Description Paragraph Right (33):
As previously mentioned, the destination data base memory card 120 contains a plurality of destinations arranged in a menu hierarchy of categories and sub-categories. According to one embodiment, the destination data base memory card 120 may contain programmed destination information as provided in FIG. 9. As shown, a plurality of destination categories 124 are provided which may include category selections such as food, hotel, gas, and other identifiable destination categories. Within each of the destination categories 124 may be a plurality of sub-categories 126. For example, within the food category may be sub-categories 126 which include fast food, casual dining, fine dining among other food sub-categories. Within the data base hierarchy of sub-categories, there may be another sub-category 128. For example, the sub-category 126 for casual dining may include further sub-categories 128 such as Chinese food, fish bar, Italian dining, pizza and steak house and other possible casual dining sub-categories.

Detailed Description Paragraph Right (34):
It should be appreciated that various levels of categories and sub-categories may be provided and selectively sequenced through to access the desired destination name, destination position coordinates and related destination information. When selecting the destination category 124, and any sub-category such as sub-categories 126 and 128, a plurality of destinations may be selected from as provided in block 130. For each destination, the corresponding latitude and longitude position coordinates are provided as shown in destination information block 132. The destination data base memory card 120 may further include additional destination information relating to the corresponding destinations as shown in block 132. The additional destination information 132 may include the address of the particular destination, the phone

number thereof and normal business hours, for example. It should be appreciated that the destination information 132 may encompass most any kind of numeric, alphabetic and symbolic text information that can be displayed on the display 30.

Detailed Description Paragraph Right (35):
Turning now to FIG. 10, the navigation menu selections and various selections within each menu selection are illustrated therein. With the use of the manually depressible navigation menu pushbutton 18, a user may select the navigation main menu. The navigation main menu includes the memory card menu selection 134, the latitude/longitude position coordinates menu selection 136 and the save/recall menu selection 138. When entering the main menu, the first menu selection, namely the memory card menu selection 134, will be displayed. A user may depress the menu choices rotary pushbutton 16 to select the menu selection shown or rotate the the rotary pushbutton 16 to sequence to another menu selection. Once in the selected navigation menu selection, a user may rotate the menu choices rotary pushbutton switch 16 to scroll through the available categories, sub-categories and destinations within the menu selection.

Detailed Description Paragraph Right (36):
In the memory card menu selection 134, a user may rotate the menu choices rotary pushbutton 16 to scroll through the destination categories 124 and view category selections such as food, hotel and gas. To select a category selection such as food, the user manually depresses the rotary pushbutton 16 when viewing the food category. With the food category selected, the display 30 will show the first selection with sub-category 126. With the use of the menu choices rotary pushbutton 16, a user may sequence through each of the selections in sub-category 126 which may include fast food, fine dining, casual dining, etc. Similarly, the user may select a displayed fast food sub-category by manually depressing the menu choices rotary pushbutton switch 16. Thereafter, individual destination names 130 may be displayed on the display 30. Again, the user may sequence through a plurality of destination names 130 such as Burger Place or Burger Hut and select the currently displayed destination name by depressing the rotary menu choices pushbutton switch 16.

Detailed Description Paragraph Right (37):
When in the latitude/longitude position coordinate menu selection 136, a user may program in a set of latitude and longitude position coordinates to identify a selected destination. For each of the latitude and longitude coordinates this includes entering in degrees/minutes/seconds in a form such as 40.degree.30'29.2N, as an example. To enter coordinate information, the user easily rotates the menu choices rotary pushbutton switch 16 to sequence through alphanumeric characters which are sequentially displayed on display 30. When a desired alphanumeric character is displayed, the user may depress the rotary pushbutton switch 16 to select the displayed character. Continued rotary sequencing and depression of the rotary pushbutton switch 16 is repeated so as to sequentially select the next characters until the latitude and longitude position coordinates are entered in.

Detailed Description Paragraph Right (38):
In the save/recall menu selection 138, a user may select between the recall destination category 140 or the save destination category 142. The recall and save destination categories 140 and 142 allow access to a user programmable data base that may be stored in EEPROM 98 or RAM 94 or 96. This user programmable data base supplements the memory card data base and allows a user to modify and add to the overall available destinations. The navigation system 10B may advantageously share programmable memory with the audio entertainment system. For example, the user programmable memory dedicated to storing radio frequency selections can also be used to store user programmed destinations.

Detailed Description Paragraph Right (39):
To select either of recall or save categories 140 or 142, a user may toggle between the two categories 140 and 142 by rotating the menu choices rotary pushbutton switch 16 and depressing switch 16 to select the displayed category. When in the recall destination category 140, a user may sequence through a plurality of user stored destinations by rotating the rotary pushbutton switch 16 and depressing switch 16 to select the stored destination that is currently shown.

Detailed Description Paragraph Right (40):
In the save destination category 142, a user may select between a current destination name category 144 and a current "where I am" position category 146 by rotating menu choices rotary pushbutton switch 16 to the desired category and depressing menu choices switch 16 to make the selection. With the current destination name category 146, the currently selected destination from the memory card 120 may be saved in the user programmable data base. In the current "where I am" position category 146, the current position of the user is saved in the programmable memory. This allows a user to save locations once visited and later recall the saved locations to obtain navigational assistance.

Detailed Description Paragraph Right (41):
Referring to FIG. 11, the methodology 174 of selecting among the various categories 124, sub-categories 126 and destinations 130 with the menu choices rotary pushbutton switch 16 is illustrated therein. The methodology 174 begins with the step 150 of selecting the memory card menu. With the memory card menu selected, a current category will be displayed 152. A user may either rotate the menu choices rotary pushbutton switch 16 to scroll through the available categories or may depress rotary pushbutton switch 16 to select the current category shown. According to step 154, if the current category shown is not selected, a user may rotate the menu choices rotary pushbutton switch 16 to the next category or categories as shown in step 156. If the user would like to select the current category, the user can depress the menu choices rotary pushbutton switch 16 to select the current category shown as provided in step 158.

Detailed Description Paragraph Right (43):
A user may sequence through as many categories and sub-categories as are necessary to select a desired destination from the destination data base. The number of sub-categories that are required to sequence through may vary. Accordingly, in step 168, the methodology 174 checks to see if the current selection is a destination. If the current selection is not a destination, the methodology 174 will return to step 160 to display the current sub-category. On the other hand, if the current selection is a destination, step 170 will display the destination name as well as the calculated distance and direction thereto.

Detailed Description Paragraph Right (44):
The menu choices rotary pushbutton control switch 16 may include the type having a grounded wiper rotatably moveable between a circular array of equi-angular space contacts in response to rotation of a control knob. A mechanical detent (not shown) on the switch 16 causes the wiper to prefer a position at each contact. Thus, the wiper "clicks" into contact at a predetermined degree of change of rotation of the position of the wiper. The term "click" is used herein to refer to the switch position changes between adjacent contacts. Clockwise rotation of rotary pushbutton control switch 16 advances to the next available selection, while a counter clockwise rotation returns to the previous available selection. According to a preferred embodiment, each rotational click switches to the next available selection. Alternately, a variable changing rate may be employed to more easily accommodate a large number of selections. That is, a user may scroll through the menu selections at a variable rate as a function of rate of change of rotation of the rotary pushbutton control switch 18. A rotary switch control which provides for such a variable rate is disclosed in U.S. patent application Ser. No. 08/179,300, filed Jan. 10, 1994, entitled "Variable Digital Control for Electronic Device with Rotary Switch Control". The present invention is assignable to the assignee of the aforementioned application.

Detailed Description Paragraph Right (45):
In addition to the menu choices rotary pushbutton control switch 16, a user may also select from the various other pushbutton navigation controls while operating and viewing the various menu selections and destination information. For example, a menu selection may be undone by depressing the undo pushbutton 22. This, in effect, undoes the last menu and returns the menu selection to the previous selection. Repeated depresses of undo pushbutton 22 sequentially back tracks through the previous selections until the main menu is reached.

Detailed Description Paragraph Right (46):
The sort by distance pushbutton 24, when depressed, will sort the destinations within a selected category or sub-category as a function of a calculated distance. With the

sort by distance pushbutton 24 momentarily depressed, the navigation system 10 will sort all destinations within the selected category or sub-category by radial distance from the current position of the user. This is accomplished by comparing the latitude and longitude position coordinates of each destination within the selected category or sub-category with the current latitude and longitude position coordinates of the user. The sorted destinations are preferably arranged in order of increasing distance so that a user may first view the closest destination and thereafter rotate the menu choices rotary pushbutton 16 to view the next closest destination, if desired. It should be appreciated that the sort by distance operation, according to one embodiment, provides a radial sort by distance which considers all destinations within a 360.degree. rotation, irrespective of their location relative to the vehicle's current direction of travel.

Detailed Description Paragraph Right (47):
With the sort by distance pushbutton 24 continually depressed for a predetermined amount of time, such as two seconds, a radial sort by distance from a selected destination may be performed. That is, instead of sorting destinations within selected categories or sub-categories from the current position of the user, a radial sort will be performed from a remote selected destination. For example, a user may perform a radial sort by distance from a selected hotel destination to determine the relative distances of available parking lots from the selected hotel. The radial sort by distance from a remote destination will provide an indication of the distance from the selected destination to each of the sorted destinations within the selected category and sub-categories.

Detailed Description Paragraph Right (48):
According to another embodiment, the sort by distance operation may be limited to sorting destinations by radial distance within a defined angular window centered about the vehicle's direction of travel. For example, all destinations within an angular field of view of forty-five degrees in front of the vehicle may be sorted radially and presented in increasing order to the user. This eliminates destinations which are located remote from the wayward course of travel. To implement a sort by distance with a limited field of view, a user may set the preferred sort mode via an additional options menu within the main menu.

Detailed Description Paragraph Right (49):
Once a destination has been selected, a user may access additional information pertaining to the selected destination. This is accomplished by depressing the information pushbutton 20. The information pushbutton 20 may be repeatedly depressed to scroll through successive displays of alphanumeric text information made available to the user. For example, the information pushbutton 20 may be depressed once to view the address information pertaining to the selected destination. The next successive depression of pushbutton 20 may display the phone number for the destination, while a third depression of pushbutton 20 may provide the normal business operating hours for the selected destination.

Detailed Description Paragraph Right (50):
As previously mentioned, the integrated navigation/audio entertainment system 10B may operate in an audio radio mode, a cassette tape mode and the navigation mode. Also, other modes of operation, such as a compact disc (CD) mode, may also be included. It should be understood that one of the audio cassette tapes or radio modes may be operating at the same time as the navigation system functions. In order to provide the proper display between the audio entertainment modes and the navigation modes, the navigation/audio entertainment system 10B is equipped with a radio display pushbutton 56 and a navigation display pushbutton 58. The radio display pushbutton 56 allows a user to view radio information on display 30 for a predetermined amount of time while operating in the navigation mode. According to one example, a time out period of five seconds may expire before returning to the navigation display mode.

Detailed Description Paragraph Right (51):
Alternately, the time out period may be infinite so as to eliminate the automatic return to the previous display mode. Similarly, the navigation display pushbutton 58 allows a user to display navigation information on display 30 when the system 10B is otherwise set in the audio entertainment mode. A time out period may likewise be used to automatically return to the audio entertainment display mode.

Detailed Description Paragraph Right (52):
The use of navigation system 10 for providing navigational services to reach a selected destination is illustrated in FIG. 12. As shown, a vehicle 110 equipped with the navigation system 10 of the present invention is shown at various locations while traveling on streets within a roadway system 176. Initially, vehicle 110 is shown providing distance and direction information with display 30 at a location 1.5 miles from a selected destination which is illustrated namely as hotel 172. As the vehicle 110 proceeds to travel along the roadway system 176, the straight-line distance and direction pointing arrow are continuously updated. The driver of the vehicle may use the straight-line direction indication and distance information to assist in making decisions on how to reach the destination 172. It should be understood that the navigation system 10 does not require the driver of the vehicle 110 to steer the vehicle 110 in the direction of the direction pointing arrow. Instead, the driver of vehicle 110 must consider roadway restrictions and traveling requirements to determine the appropriate route of travel to destination 172.

Detailed Description Paragraph Right (53):
As the vehicle 110 approaches destination 172 to within a distance of 0.1 miles, the display 30 will display "nearby" and the navigation system 10 will sound an audible alarm signal. According to one embodiment, the audible alarm signal may be produced by audible tones. With the navigation/audio entertainment system 10B, the audible alarm may be produced with audible tones or output from audio speakers 65. If the vehicle 110 proceeds beyond the destination 172, the display 30 will return to displaying the current straight-line direction pointing arrow and distance from the current vehicle position to the destination 172.

Detailed Description Paragraph Right (54):
Referring now to FIG. 13, the methodology 180 of continuously determining the straight-line distance and direction to a selected destination is illustrated therein. The methodology 180 begins with the entering of the navigation mode as provided in step 182. The user may select the desired destination according to step 184. The navigation system 10 will then determine the most recent vehicle location and direction heading information as shown in step 186.

Detailed Description Paragraph Right (55):
To obtain the most recent vehicle location and direction heading information, the methodology 180 will check to see if the GPS solution is currently available pursuant to step 188. If the GPS solution is available, the current location is updated with the GPS data as provided in step 190. At the same time, the methodology 180 will continuously monitor vehicle speed to see if the vehicle speed is greater than a predefined speed of say five miles per hour, for example, as shown in step 192. Referring to step 194, if vehicle speed is greater than five miles per hour a new heading is derived from a GPS velocity value and the distance and direction information is computed according to step 200. If, however, the determined vehicle speed is not greater than five miles per hour, a new heading is derived from the current compass reading as provided in step 196 and the computed distance and direction information are calculated according to step 200.

Detailed Description Paragraph Right (56):
Should the GPS solution not be available as detected in test step 188, the new location is computed from the old location information with the addition of a dead reckoning system as shown in step 198. Currently, existing global positioning systems have been known to suffer from signal blockage caused by tall buildings and other interferences. When the GPS signal is unavailable, the present invention takes into account for any such interferences and enables the navigation system 10 to continue to operate despite the occurrence of GPS interference or other causes of unavailability of GPS. For example, in a typical urban environment, a vehicle may travel a roadway system between various tall buildings in which the GPS radio wave signals may be blocked by an obstruction caused by nearby buildings. This interference condition is known as the occurrence of GPS fade. In order to handle the GPS fade scenario, the navigation system 10 advantageously stores the last set of position coordinates and calculated speed and direction information, in addition to the time the last position coordinates were recorded. With the dead reckoning sensor information, given the vehicle speed sensor signal 76, the transmission position signal 78, compass reading

74 and time related information, the navigation board microprocessor 92 is able to determine an approximate expected location of the mobile user, despite the unavailability of GPS signals. Given the dead reckoning system information and calculations, the methodology 180 is able to derive the new direction heading from the current compass reading pursuant to step 196 and thereafter compute the straight-line distance and direction according to step 200.

Detailed Description Paragraph Right (57):
With the distance and direction computed, the methodology 180 will check to see if the user is near the destination to within a predefined distance of 0.1 mile, for example. If the vehicle is within 0.1 miles of the destination, an audible alarm is sounded and the display displays "NEARBY" as shown in step 206. Otherwise, the display will provide an indication of the straight-line direction to the destination and the distance therebetween as shown in step 204. In any event, the methodology 180 will check for a new destination requested as shown in step 208 and then return to block 184.

Detailed Description Paragraph Right (58):
Referring now to FIGS. 14A through 14C, the sequencing of menu selections and displays are illustrated for selecting a destination and destination information from the destination data base stored in memory card 120. With particular reference to FIG. 14A, display block 210 illustrates the initial display 30 showing the navigation menu in capital letters on the top line of text and the selectable memory card menu in small case letters on the bottom line of text. Selection of the memory card menu advances to display block 212 where the geographic territory of coverage provided with the given memory card is illustrated by the description "ANYTOWN USA". Also shown on the bottom line of text is the first category, shown here as the "food" category selection.

Detailed Description Paragraph Right (59):
A destination category selection which a user may change or select is generally shown preceded by the addition of a carrot sign (>). Selection of the "food" category advances to display block 214 in which the first selection of a sub-category is shown as the "fast food" sub-category. Selection of the "fast food" sub-category with the menu choices rotary pushbutton 16 advances to display block 216. Within the "fast food" sub-category, a user may select one of several available destinations names such as "Burger Hut". An individual destination name is shown preceded by a filled carrot sign ().

Detailed Description Paragraph Right (60):
Once a destination has been selected, additional information may be displayed and explored. For example, given display block 216, the information pushbutton 20 may be depressed to display the updated straight-line distance and direction from the current position to the selected destination, namely Burger Hut, as shown in display block 218. Repeated depression of information pushbutton 20 will advance to display block 220 which displays the full descriptive name of the selected destination. Depression of information pushbutton 20 again will advance to display block 222 to display the address of the selected destination. Another depression of information pushbutton 20 will display the phone number for the selected destination as shown in display block 224.

Detailed Description Paragraph Right (61):
Referring again to display block 216, depression of menu choices rotary pushbutton 16 will advance to display block 226 to display the direction pointing arrow as well as the destination name and distance from the current position to the selected destination. In addition, the time of day may be displayed as shown. Repeated depressions of information pushbutton 20 will scroll through and display the text information that is available. For example, a first depression of information pushbutton 20 will display the destination name as provided in display block 228. Another depression of information pushbutton 20 will display the address of the destination as shown by display block 230, while a third depression of pushbutton 20 will display the phone number of the selected destination as shown in display block 232.

Detailed Description Paragraph Right (62):

Each time the information pushbutton 20 is depressed, information is retrieved and shown for a given block of information. Repeated depressions of information pushbutton 20 retrieve successive frames of information that are made available to the user. Each time the information pushbutton 20 is depressed, a timer is set to expire after a time period T.sub.0 equal to five seconds, for example. When the timer expires, the display will return to the last display shown prior to the initial operation of information pushbutton 20.

Detailed Description Paragraph Right (63):
Referring next to FIG. 14B, similar sequencing and displays are shown when selecting one destination from a plurality memory card destinations which have the same name. As shown in FIG. 14B, the display blocks are substantially the same as those in FIG. 14A, except for the addition of display block 234 which identifies one of a plurality of fast food restaurants having identical names, herein shown as Burger Hut. In addition, display block 234 provides the address for the destination shown. It should be understood that a user may rotate menu choices rotary pushbutton switch 16 to sequence through the plurality of same name destinations and depress switch 16 to select the currently shown destination.

Detailed Description Paragraph Right (64):
In FIG. 14C, key sequences and displays are shown when selecting destinations sorted by radial distance from the current position of the user. The display blocks 210 through 224 and block 234 are substantially identical to those provided in FIG. 14B. However, at display block 234, a user depresses the "sort by distance" pushbutton 24 to advance to display block 236. The sort by distance operation will compare all destinations within the selected category and sub-categories by radial distance from the current position of the navigation system 10. The compared destinations are also sorted and arranged in order of increasing distance from the current position. For example, the sort by distance operation shown will sort all destinations within the sub-category entitled Burger Hut. This allows a user to easily view the closest destination first, and then sequence to the next closest destination, if desired.

Detailed Description Paragraph Right (65):
With the desired destination selected, a user may depress the information pushbutton 20 to advance to display block 238 which provides the descriptive name of the destination. Additional depressions of information pushbutton 20 will advance to display block 240 to provide the address and then to display block 242 to give the phone number of the destination. Returning to display block 236, depression of the menu choices rotary pushbutton switch 16 will advance to display block 244 to further illustrate the direction pointing arrow, destination name and calculated straight-line distance to the selected destination. Similarly, depression of information pushbutton 20 advances to display block 246 to provide the destination name, and further to display blocks 248 and 250 to provide the address and phone number, respectively.

Detailed Description Paragraph Right (66):
Turning now to FIG. 15, key sequences and displays are illustrated when entering a destination by the latitude and longitude position coordinates. In doing so, the navigation menu selection is performed with menu choices rotary pushbutton 16 to display the latitude/longitude menu selection as shown in display block 252. Depression of the menu choices rotary pushbutton 16 will select the latitude/longitude menu and advance to display block 254. In display block 254, the user is asked to enter a set of latitude position coordinates. The latitude position coordinates include degrees/minutes/seconds. To enter in the latitude coordinates, the menu choices rotary pushbutton 16 is rotated until a desired character is displayed. With the desired character displayed, a user may depress the rotary pushbutton 16 so as to select that character. The display will then move to the next character position so that the user may then enter in the next character and so on until the latitude position coordinates are entered as shown in display block 254.

Detailed Description Paragraph Right (67):
Once the latitude coordinates are entered, the user may depress the rotary pushbutton 16 again to advance to display block 256. In display block 256, the user is asked to enter a set of longitude position coordinates by entering degrees/minutes/seconds. A user will rotate the menu choices rotary pushbutton 16 to select and choose the longitude position coordinates as shown in display block 256. Once the longitude and

latitude position coordinates are entered, the information pushbutton 20 may be depressed to toggle between the user entered latitude and longitude position coordinates as shown in display blocks 256 and 258. If the latitude and longitude coordinates are correct, the user may depress rotary pushbutton 16 to advance to display block 260.

Detailed Description Paragraph Right (68):
As shown in display block 260, the longitude and latitude position coordinates as entered may be saved in the user programmable memory location. As shown, however, the entered position coordinates shown are not. saved and the display advances to display block 262 in which the latitude and longitude position coordinates are displayed as well as the direction pointing arrow and the straightline distance and time of day. Depression of information pushbutton 20 will advance to block 264 which shows the latitude coordinates on the top line and the longitude coordinates on the bottom line. Additional depressions of information pushbutton 20 will advance to display blocks 266 and 268 which show latitude and longitude positions coordinates titled by name.

Detailed Description Paragraph Right (69):
Referring now to the save/recall menu operation, key sequences and displays are shown in FIGS. 16A through 16E for illustrative purposes. Referring to FIG. 16A, the key sequences and displays are shown when saving the current "where I am" user position as a destination. Beginning with display block 270, the navigation menu shows selection of the save/recall menu. Depression of menu choices rotary pushbutton 16 advances to display block 272 which displays the save destination category. Selection of the save destination category advances to display block 274 where the user may select the "where I am" selection for saving the current position in the user programmable memory. To check the current position, a user may depress information pushbutton 20 to view the current latitude position coordinates in display block 276 and the current longitude position coordinates in display block 278.

Detailed Description Paragraph Right (70):
To save the current position coordinates, the menu choices rotary pushbutton 16 is depressed to advance to display block 280. In display block 280, the user may select which programmable memory location to use to store the current position as a user selectable destination. By depressing information pushbutton 20, the user may display information pertaining to the old destination stored in a currently shown memory location. For example, display blocks 282, 284 and 286 may be viewed so a user may determine whether to copy the current position over the old location information. Alternately, information pertaining to old coordinates as shown in display blocks 288, 290 and 292 may be viewed.

Detailed Description Paragraph Right (71):
Once a user selects the desired memory location, a descriptive name may be entered to indentify the current position being saved. Verification of the stored name is provided in display block 296 and the navigation system 10 returns to the last navigation mode.

Detailed Description Paragraph Right (72):
Key sequencing and displays for storing a user selected destination as the last entry is illustrated in FIG. 16B. The save/recall menu selection and save destination categories are selected as shown in display blocks 270 and 272. Referring to display block 298, a user may select to save the last entered destination, shown here as "Burger Hut". Depression of information pushbutton 20 provides additional information as shown in display blocks 300, 302 and 304.

Detailed Description Paragraph Right (73):
To save the last entered destination, menu choices rotary pushbutton 16 is depressed to advance to display block 280 to select the user programmable memory location in which to save the last destination entry. Similarly, information pertaining to an old entry for a currently shown memory location may be viewed by depressing the information pushbutton 20 to proceed to display blocks 282 through 292. The desired memory location is selected and the current destination last entered is saved in the corresponding memory location as shown in display block 306. The navigation system 10 thereafter returns to the last mode.

Detailed Description Paragraph Right (74):
Key sequences and displays are shown in FIG. 16C when storing a user destination last entered by latitude and longitude position coordinates. The save/recall menu and save destination category are selected as shown by display blocks 270 and 272. With the save category selected, the last entered destination may be saved with the latitude and longitude position coordinates as shown in display block 308. The latitude and longitude position coordinates for the last entered destination may be viewed as shown in display blocks 310, 312 and 314. To save the current latitude and longitude position coordinates, the menu choices rotary pushbutton 16 is depressed to advance to the display block 280 and destination storage in a user programmable memory location is achieved as described in connection with FIGS. 16A and 16B.

Detailed Description Paragraph Right (75):
Referring to FIGS. 16D and 16E, key sequences and displays are shown for recalling user stored destinations. In FIG. 16D, user stored destinations are recalled from the user programmable memory locations which were previously stored from the destination data base in the memory card. With the save/recall menu selected in block 270, the recall destination category 140 is selected as shown in display block 316. The recall destination category allows for sequencing through a predetermined number of available memory locations. By rotating the menu choices rotary pushbutton 16, user may view destination names given to the individual memory locations. Within each destination name, additional destination information may be viewed by depressing the information pushbutton 20 as shown in display blocks 320, 322, 324 and 326. Once a particular memory location is selected, the destination name, direction pointing arrow to the destination and distance to the destination is shown on display 30 as provided by display block 328. Information pushbutton allows for viewing of additional information corresponding to the selected destination and as provided in display blocks 330, 332 and 334.

Detailed Description Paragraph Right (76):
Finally, referring to FIG. 16E, stored destinations which were previously stored as latitude and longitude position coordinates are now recalled under the recall destination category. Recalling the desired destination is achieved in a manner similar to that described in connection with 16D. However, the information provided with regard to each of the selectable destinations provides the latitude and longitude position coordinates as shown in display blocks 336, 338, 340 and also in display blocks 342, 344 and 346.

Detailed Description Paragraph Right (77):
It should be understood that the navigation system 10 of the present invention advantageously provides low cost and easy to use navigation services for assisting a user in reaching a desired destination. The navigation system 10 is a tool for assisting a user to reach a destination, while allowing a user to independently make decisions on the appropriate route to reach the destination. While the navigation system 10 is described in connection with an automotive vehicle for assisting the driver thereof, it should be understood that the navigation system 10 is applicable for a wide variety of applications which generally require travel to reach a desired destination.

CLAIMS:

1. A mapless navigation system with a user modifiable data base for adding data, including coordinate data, to previously stored data and for recalling the data, said mapless navigation system comprising:

a position sensing receiver for receiving position information and determining a current position thereof;

a user modifiable destination data base internal to the navigation system with programmable memory for adding information to existing destinations to the data base and for adding coordinates of and other information regarding new destinations including said current position as a new destination to said data base;

user interface means in said system for accessing the user modifiable data base, for adding said information to the user modifiable data base, and for recalling database

information, including the added information on destinations;

user selectable input means for selecting a desired destination from the user modifiable data base, including the destination added by a user of the data base;

processor means for determining a distance and a direction from the determined current position to the selected desired destination; and

a mapless display for displaying said distance from the current position to the selected desired destination, and a direction pointing indicator in said display for indicating said direction from the current position to the selected desired destination.

2. The navigation system as defined in claim 1 wherein said position sensing receiver provides coordinates for the added destination to said user modifiable database.

3. The navigation system as defined in claim 2 wherein said user modifiable data base is contained in a memory card and the user interface means includes means for transferring said coordinates from said position sensing receiver to said user modifiable database.

4. The navigation system as defined in claim 3 wherein said coordinate transfer means includes a pushbutton that actuates transfer of coordinate data from said position sensing receiver to said user modifiable data base.

5. The navigation system as defined in claim 4 wherein said user modifiable data base includes a portion that is non-modifiable and the non-modifiable portion is contained in said memory card accessed via a memory card interface.

6. The navigation system as defined in claim 3 wherein said coordinate transfer means includes a rotary pushbutton switch that is rotatable for selecting available memory locations and axially depressible for storing a user specified destination in one of the available memory locations.

7. The navigation system as defined in claim 5 wherein said pushbutton for storing the current position as a user specified destination is a rotary pushbutton switch that is rotatable for selecting available memory locations and axially depressible for storing the current position as said user specified destination.

8. A method of providing navigational assistance to a mobile user of mapless navigation system, said method comprising the steps of:

receiving GPS signals containing position latitude and longitude information on current position of the mapless navigation-system;

providing a memory card in the mapless navigation system having a user modifiable data base thereon containing latitude and longitude coordinates and associated identifying destinations therefor;

providing an identifying destination for association with the current position latitude and longitude coordinates;

storing the identifying destination in association with its current position latitude and longitude coordinates in the user modifiable data base;

selecting one of the stored identifying destinations and its associated coordinates from the user modifiable data base;

determining a distance and a direction from the current position to the selected coordinates; and

displaying the determined distance and a direction pointer indicating the direction from the current position to the selected coordinates on a mapless display.

9. The method as defined in claim 8 further comprising the step of reading categorized

destinations and corresponding latitude and longitude position coordinates of the categorized destinations from the user modifiable destination data base stored on said memory card.

L11: Entry 51 of 86 File: USPT Sep 1, 1998

DOCUMENT-IDENTIFIER: US 5802492 A
TITLE: Computer aided routing and positioning system

Abstract Paragraph Left (1):
A Computer Aided Routing and Positioning System (CARPS) determines a route along selected waypoints that include a travel origin and a travel destination and intermediate waypoints therebetween. The selected waypoints may be uploaded to or downloaded from various geocoding devices that utilize the Global Positioning System (GPS). A CARPS database incorporates travel information selected from a range of multimedia sources about the transportation routes, waypoints, and geographically locatable points of interest (POIs) selected by the user along the travel route. The CARPS software permits user selection of specified POI types within a user-defined region of interest and user selection of particular POIs from the selected types within the region of interest. The transportation routes, waypoints, POIs and region of interest are identifiable in the computer by coordinate locations of a selected geographical coordinate system. The CARPS software is constructed to present a user-customized travelog for preview on the computer display of the user-defined travel route. The travel planner can preview on the computer display a multimedia travelog particularly customized for the user-defined travel route including multimedia information on the transportation routes, waypoints, and POIs selected by the user. The user can engage in an iterative trip planning process of revising the route and previewing travelogs of revised travel routes until a satisfactory travel route is determined. Hardcopies of customized travel maps of the user-defined travel route can be used in conjunction with a GPS device which has been uploaded with selected waypoint data.

Parent Case Paragraph Right (1):
This patent application is a continuation-in-part (CIP) of the David M. DeLorme et al U.S. patent application Ser. No. 08/381,214 filed Jan. 31, 1995, now U.S. Pat. No. 5,559,707 for COMPUTER AIDED ROUTING SYSTEM which is a CIP of the David M. DeLorme et al U.S. patent application Ser. No. 08/265,327 filed Jun. 24, 1994, now abandoned for COMPUTER AIDED MAP LOCATION SYSTEM and the contents of these related patent applications are incorporated herein by reference.

Brief Summary Paragraph Right (1):
This invention relates to a new Computer Aided Routing and Positioning System (CARPS) for travel planning, travel guidance, and recording travel locations and paths during business or recreational use. The invention provides an interactive computer travel planning guide for determining a route between a user selected travel origin and travel destination following user selected intermediate waypoints along the way. CARPS software determines the preferred travel route within user selected constraints. The user can also select among a plurality of types of geographically locatable points of interest (POIs) within a user-defined region of interest along the travel route. A CARPS database incorporates travel information such as graphics, photos, videos, animations, audio and text information about the user selectable POIs along the way as well as about transportation routes and waypoints. From the user selected and user-defined transportation routes, waypoints, and POIs along the travel route, the CARPS software constructs a user customized multimedia travelog for preview on a computer display of the user-defined travel route. Based on the user customized previews, the travel route including transportation routes, waypoints, and points of interest can be updated or changed according to the user preferences and choices. Modified travel routes can be previewed with further multimedia travelogs until a

satisfactory travel route is achieved. The CARPS software user can then output a travel plan, i.e, downloading waypoints electronically and/or printing out maps with route indications and text travel directions.

Brief Summary Paragraph Right (2):
The CARPS is also applicable for use with the Global Positioning System (GPS), radio location systems, dead reckoning location systems, and hybrid location systems. For example, the GPS satellite system is used with a GPS receiver for displaying waypoint data and limited routing data of the CARPS user on the computer display for correlation of location with surface features or mappable features. Data generated by the GPS receiver may be used for "real time position updates" in the CARPS computer display or may be recorded by the GPS receiver in the field for subsequent downloading to CARPS software and CARPS computer display. As well, CARPS-generated data may be used within the GPS receiver by a CARPS user for guidance in the field apart from a desktop CARPS platform. The user can follow the CARPS generated route using just a GPS device alone, or with the further aid of other CARPS output such as printed maps. This can be accomplished visually and intuitively between human readable forms of a map without the necessity of a users physical determination of latitude and longitude and without requiring any mathematical calculations by the user. Text and voice or audio outputs can be provided to facilitate use and reading of the printed maps and/or GPS devices. The invention also adds a communications dimension to the maps for adding and updating the latest spatially related data, for providing software tools for map analysis and reading, and generally for communications between computer systems and devices and between users in a variety of combinations.

Brief Summary Paragraph Right (5):
Similarly the American Automobile Association in cooperation with Compton's NewMedia also provides travel planning from starting point to destination point with stopping points in between. The CDROM product contains a database of travel information. However the multimedia information available from the database appears limited to "suggested routes of travel" again limiting user choice.

Brief Summary Paragraph Right (7):
Relatedly, there are a variety of mapping and positioning systems. One such system is a hand-held personal GPS navigation tool that has been developed by the Garmin Corporation of Lenexa, Kans. under the tradename Garmin GPS 45. The Garmin navigation tool incorporates a GPS receiver and a limited character display screen for displaying position information in alphanumeric and graphic characters. Another such system is a hand-held personal GPS navigation tool that has been developed by Trimble Navigation of Austin, Tex., under the trademark Scout GPS (TM). The Trimble navigation tool incorporates a GPS receiver and a four-line character display for displaying position information in alphanumeric characters. This hand-held GPS system can apparently display alphanumeric position information in a latitude/longitude coordinate system or a Universal Transverse Mercator (UTM) coordinate system. The Trimble navigation tool can apparently also display proprietary coordinate system information for locating the position of a user on a standard topographic map. The Trimble GPS navigation tool displays in alphanumeric characters the horizontal and vertical coordinate distances of the user from the southeast corner or southeast reference point of any standard topographic map.

Brief Summary Paragraph Right (8):
A disadvantage of the Trimble GPS navigation tool is that it provides a display of coordinate system data only in alphanumeric characters on a multiline LCD display. The user must then perform mathematical measurements and operations to determine the user location on a particular topographic map. While the incorporation of GPS technology provides an improvement over dead reckoning and position estimation from topography, it necessarily requires user reference to quantitative measurements and calculations. Furthermore, the Trimble navigation device does not provide communications access to other geographical information databases for updated information on geographical objects in the spatial area of interest or communications access to other software tools for map analysis and reading. More generally, the Trimble navigation device does not provide a communications dimension for the map reading system.

Brief Summary Paragraph Right (9):
Silva Sweden AB and Rockwell International USA have developed a hand-held GPS compass

navigator for use on any standard map. The GPS compass navigator incorporates a GPS receiver for locating the user on any standard map. A built-in "compass" gives range and bearing from the known user position to a specified destination. This information is updated on the GPS compass navigator as the user progresses toward the destination. The GPS compass navigator is described as being in the form of a guiding "puck" that apparently rides or is moved over the standard map at the user location. It therefore cannot display multiple geographical objects at the same time and cannot communicate with other sources of spatially related map information.

Brief Summary Paragraph Right (10):
Prior-art attempts at combining a GPS device with electronic maps exist, but these attempts have not been able to provide GPS devices with optimized routing data used independent from the electronic maps. Accordingly, there is a need to link GPS devices with travel planning, map display, and customization of routes so that GPS devices may provide remote guidance along optimized routes. On-site locational information which may be recorded or tracked by the GPS device in the field should be transferrable to a routing and positioning system. As well, a routing and positioning system should be able to generate information that is transferrable to a GPS device. Such objects will become apparent with reference to the present invention as described below.

Brief Summary Paragraph Right (11):
It is therefore an object of the present invention to provide a new computer aided routing and positioning system (CARPS) capable of determining a travel route between a user-selected travel origin and travel destination following user-selected waypoints of interest along the way. A feature of the invention is that the user can construct a highly selective travel route incorporating waypoints selected by the user.

Brief Summary Paragraph Right (13):
Still another object of the invention is to provide CARPS software capable of presenting a user customized travelog or sequential assemblage of multimedia information for preview on the computer display about the user-defined travel route. The travelog includes multimedia information about the transportation route, waypoints, and selected POIs in the user-defined region of interest along the travel route.

Brief Summary Paragraph Right (14):
A further object of the invention is to provide a CARPS for use with radio location systems, dead reckoning location systems, and hybrid location systems for displaying user location. For example, the GPS satellite system can be used for displaying the location, direction of travel, route, speed, and other travel data of a CARPS user on a generalized grid quadrangle for correlation of user location on a coinciding printed map. Such is accomplished by direct sensory, visual, and intuitive methods. As well, the GPS satellite system may be used in the field for recording waypoint data and limited routing data of a CARPS user for later data transfer and CARPS computer display. Additionally, the GPS satellite system may be used in the field for updating waypoint data and limited routing data of a CARPS user for immediate data transfer via wireless data communications and remote CARPS computer display at a CARPS desktop platform.

Brief Summary Paragraph Right (17):
Another advantage is that CARPS users in the field may simultaneously navigate a travel route generated by CARPS software while recording or tracking locations or sequences of locations. Such locations may be designated by the user as new POI's and sequences of locations may be transferred from the GPS receiver to the CARPS desktop platform as an ordered waypoint list that designates a new travel route. Further, fast and accurate surveying is enabled from GPS receiver location recording data made by the user in the field when transferred to the CARPS desktop platform for computerized data mapping by the CARPS software.

Brief Summary Paragraph Right (18):
In order to accomplish these results the present invention provides CARPS for use with a digital computer, digital computer display, and a detachable handheld GPS device such as a Garmin GPS 45 Personal Navigator (TM) which provides waypoint list management tools and compass bearing, distance, speed of travel, estimated time until arrival, and other information in relation to the next waypoint on an overall route. A

variety of other peripheral equipment is also provided as hereafter described. A set of electronic maps is provided for presentation on the computer display. The electronic maps depict transportation routes having route intersections and identified waypoints at geographical locations along the transportation routes. The route intersections and identified waypoints depicted on the electronic maps are identified in the computer by coordinate locations of a selected geographical coordinate system.

Brief Summary Paragraph Right (19):
A CARPS database contains geographically locatable objects (loc/objects) also referred to as points of interest (POIs) identified by coordinate locations in the geographical coordinate system. The POIs are organized into a plurality of types for user selection of loc/objects or POIs individually and by type. The loc/object or POI types constitute electronic overlays of the database for display over the electronic maps on the computer display. As used in this specification and claims, the phrase points of interest or POI's is generally used to refer to loc/objects for which multimedia information is available for describing the POI's and presenting the points of interest in a multimedia travelog as hereafter described.

Brief Summary Paragraph Right (21):
The computer aided routing and positioning system incorporates (CARPS) software constructed for user travel planning using the electronic maps presented on the computer display. The CARPS software permits user selection of a travel origin, travel destination, and desired waypoints between the travel origin and travel destination. The CARPS software calculates, delineates and displays a travel route between the travel origin and the travel destination via the selected waypoints. The travel route is calculated according to user choice of the shortest travel route, quickest travel route, or user determined preferred travel route. As used in the specification and claims, waypoints refers to the origin and destination of a possible route and intermediate points or places along the way including major road and highway intersections, joints or turning points at connected short line segments of major roads and highways, place names situated on major roads and highways, and as hereafter described, POIs near the major roads and highways.

Brief Summary Paragraph Right (23):
The CARPS database also incorporates travel information about the POIs identified in the database and about selected transportation routes and waypoints of the electronic maps. The travel information may be from a variety of multimedia sources and is for example selected from the group consisting of graphics, photos, videos, animations, audio and text information, etc. As hereafter described the multimedia travel information is subject to a high degree of user selectivity in composing customized multimedia travel information packages.

Brief Summary Paragraph Right (24):
The CARPS software is also constructed to present a user customized travelog for preview on the computer display of the user-defined travel route. Thus multimedia travel information is assembled from the CARPS database on the transportation routes and waypoints of-the electronic maps and the selected POIs of the database in the user-defined region of interest along the travel route.

Brief Summary Paragraph Right (25):
A feature and advantage of CARPS is that the travel planner can preview on the computer display a travelog particularly customized for the user-defined travel route including multimedia information on the transportation routes, waypoints, and POIs selected by the user. The trip planner is not constrained to viewing "canned" or preselected multimedia assemblages and travelogs for suggested routes planned by other editors. Rather CARPS delivers a user customized travelog or multimedia information assemblage directed specifically to the user-defined travel route including the user-selected transportation routes, waypoints and POIs.

Brief Summary Paragraph Right (27):
A feature of the invention is that one or more points of interest in the user-defined region of interest along a travel route can be converted by the user to waypoints on a new travel route. The POI status therefore changes from a possible side excursion off the main travel route to an actual waypoint on the new or revised travel route. The user therefore has available a wide selection of possible sites for defining a travel

route including route intersections, named places on the electronic map, and the array of geographically locatable objects about which there is multimedia information and therefore referred to as points of interest of the CARPS database.

Brief Summary Paragraph Right (28):
In the preferred example the CARPS software is constructed to display a user customized strip map of the user-defined travel route. The user customized strip map is typically displayed along the center of the computer display. User-selected POIs in the user-defined region of interest are listed along one side of the strip map with pointers to respective POI locations in the region of interest. Travel directions for the travel route are listed along the other side of the strip map with pointers to respective intersections corresponding to directions along the travel route.

Brief Summary Paragraph Right (29):
Preferably the strip map is vertically oriented with the travel origin at the bottom of the strip map and travel destination toward the top of the strip map. An advantage of this arrangement is that the strip map and travel route are always oriented in the direction of travel and the right and left directions coincide with actual right and left directions.

Brief Summary Paragraph Right (30):
In the preferred example the digital computer also incorporates a printer and the CARPS software is constructed for printing hardcopy maps of the user customized strip maps. The hardcopy maps of the user customized strip maps show the travel route, list of POIs and pointers along one side of the strip map, and list of directions and pointers along the other side of the strip map. The printed hardcopy map is preferably vertically oriented also with the travel origin at the bottom of the strip map and travel destination toward the top of the strip map.

Brief Summary Paragraph Right (31):
The electronic maps, CARPS database, and CARPS software are typically stored on a CDROM and the digital computer incorporates a CDROM drive. The CARPS software may include a replace function for updating the electronic maps and CARPS database on the CDROM with replacement or supplemental information from another memory device.

Brief Summary Paragraph Right (32):
CARPS works with a geographic information system or GIS managing data in relation to specific geographic coordinates. The GIS enables display of electronic maps which function as a user interface as well as a system for display of geographic data. The GIS and the mapping interface coordinate two broad types of data: (1) transportation routes or networks and nodes or waypoints subject to routing computations; and (2) POIs or loc/objects related to information about travel and locations in various media.

Brief Summary Paragraph Right (33):
Transportation routes depicted on the electronic maps may include all forms of transportation routes for example selected from the group consisting of vehicle routes, ferry routes, air travel routes, bicycle routes, and hiking trails. Such routes are typically represented as line segments, vectors or networks appropriate to the modes of transportation involved. The GIS and the user manage and manipulate such routing data in terms of geographic points including intersections, terminals, junctions and connections, generally labelled "nodes". Particular travel plans or itineraries along available transportation routes entail specific selections and arrangements of nodes called "waypoints". Users enter or list waypoints in the order of an intended journey including a point of departure, optionally intermediate stops or places to pass through on the journey, plus a final destination. In summary, nodes comprise the possible waypoints from which the user composes waypoint lists or input for routing.

Brief Summary Paragraph Right (35):
CARPS permits the user to locate, click on or otherwise choose such nodes or possible waypoints and POIs in order to develop his or her individual travel plan. The CARPS software is also constructed for incorporating POIs selected by the user, while playing related multimedia in the region of interest, as new waypoints in the user-defined travel route. The CARPS software can then recalculate, delineate and

display a new user-defined travel route via the selected loc/objects or points of interest treated as added waypoints. The CARPS database or GIS also stores information about the transportation routes entering and leaving the respective waypoints as well as the identity of immediately adjacent nodes.

Brief Summary Paragraph Right (38):
The invention also provides a set of printed maps substantially coinciding with the set of electronic maps for user cross reference, correlation and coordination between the computer display presented electronic maps and the printed maps. A grid system of grid lines preferably overlays the electronic maps and the printed maps. The grid lines define uniquely named grid quadrangles. The uniquely named grid quadrangles of the electronic maps and printed maps substantially coincide in geographic areas depicted by the grid quadrangles to facilitate cross reference, correlation and coordination between the computer display map presentations and the corresponding printed maps, as set forth in further detail in the related patent application cross referenced above.

Brief Summary Paragraph Right (39):
The electronic maps and printed maps are constructed to be substantially constant-scale maps. The electronic maps may be at a plurality of scales, each scale level incorporating substantially constant-scale maps. In that case the grid system also incorporates a plurality of sets of grid lines corresponding to the respective scales and defining uniquely named grid quadrangles at each scale. The CARPS software is constructed to permit user scrolling across grid quadrangles at the same scale and to permit zooming between grid quadrangles at different scales. The scrolling and zooming steps are displayed on the computer display. Further details on the scrolling and zooming capabilities of the mapping database manager are set forth in the David M. DeLorme U.S. Pat. No. 4,927,319 issued Nov. 20, 1990 for ELECTRONIC GLOBAL MAP GENERATING SYSTEM and the David M. DeLorme U.S. Pat. No. 5,030,117 issued Jul. 9, 1991 for DIGITAL GLOBAL MAP GENERATING SYSTEM. The digital computer may be selected from a range of hardware either portable or stationary including PDA's, notebooks, portable computers, GPS receivers, desktop computers, workstations, and mainframes.

Brief Summary Paragraph Right (40):
Generally the CARPS software of the invention is constructed so that the trip planner can easily change any of the user-selected parameters such as user-selected travel origin, travel destination, transportation routes, and waypoints. POI's can also be incorporated as waypoints along the route. The CARPS software recalculates, delineates, and displays on the computer display the revised travel route. It also assembles and displays a revised user customized multimedia travelog for previewing the revised travel route. Waypoints may be selectively uploaded or downloaded between GPS receivers and CARPS software. These steps can be repeated in an iterative trip planning process until the user arrives at a satisfactory user-defined travel route.

Brief Summary Paragraph Right (42):
Alternatively or in addition, a radio location receiver such as a GPS receiver is coupled to the CARPS software. The CARPS software can be programmed to display the location of a user based on signals from the GPS receiver or other radio location receiver in a selected grid quadrangle image. A full screen can be constituted to be the selected grid quadrangle. Or, multiple grid quadrangles may be displayed. The GPS receiver can also be used in conjunction with CARPS map displays and printed maps without grid quadrangles. The user correlates and coordinates locations on the grid quadrangle computer display with locations on a corresponding grid quadrangle of a printed map. Additional travel data can also be displayed including user direction of travel, velocity, altitude, and route traveled, all derived from the GPS receiver or other radio location receiver. In addition to radio location, other user location systems may also be incorporated into the CARPS such as dead reckoning location systems that measure user location from a known origin. Hybrid location systems are also available combining radio location and dead reckoning.

Brief Summary Paragraph Right (43):
The CARPS user can be provided with communications links for on-line communication and transfer of spatially related data and software tools for map reading between computers and between users. For example a CARPS user may communicate with another CARPS system or user for transfer of user location data and any other spatially

related data. The CARPS user can communicate with external databases, a central communications service bureau, and on-line mapping services for latest information relating to loc/objects, routes, and map modifications, priority messages, etc.

Brief Summary Paragraph Right (44):
According to another preferred embodiment of the invention, the CARPS software is coupled to a radio location receiver such as a loran receiver or a GPS receiver for generating signals corresponding to the geographical coordinate location and direction of travel of a CARPS user. Dead reckoning location systems and hybrid location systems may also be used. The database manager is constructed for displaying on the CARPS computer display the location, direction of travel, speed and traveling route of the CARPS user. The displayed location and route can be correlated with locations on the printed map coinciding in geographic area with the selected grid quadrangle. The GPS receiver loaded with CARPS data can be used in a separate and independent CARPS system without any databases of loc/objects as a stand-alone system or in combination with the second database and other available internal and external databases for display of selected loc/objects from such databases. CARPS and users can exchange data for display or other use such as user location information as well as other spatially related data. This is accomplished over a variety of communications links, wired or wireless, adding a communications dimension to the CARPS.

Brief Summary Paragraph Right (45):
While the description of the present invention is primarily directed to the applications of the invention for computer-aided map reading, analysis and interpretation and for supplementing the maps with spatially related data from databases derived from memory devices and communications links, the invention is also applicable for map making and map creation. A detachable, portable GPS receiver can be used to record waypoints in the field for later downloading into CARPS for display and processing. Thus, the GPS receiver may communicate GPS location data from on-site geocoding to a home office CARPS system for accumulation and assembly of mapping data. At the same time the invention can provide on-line mapping information services to other CARPS systems and users.

Brief Summary Paragraph Right (46):
The invention also provides a new Computer Aided Routing and Positioning Method (CARPM) using a digital computer with computer display and electronic maps in combination with a GPS receiver for portable waypoint guidance, updating, and recording. As noted above, the electronic maps include transportation routes, route intersections and identified waypoints along the transportation routes. The method also uses CARPS software for user travel planning.

Brief Summary Paragraph Right (47):
The method steps of the invention include presenting the electronic maps on the computer display, selecting waypoints by using the electronic maps, or by list-based sources for locating by place names, zip codes or telephone exchange data etc., or by responding to related multimedia about proximate points of interest, or by recordation via a geocoding device. The waypoints include a user travel origin and travel destination, and intermediate waypoints of interest at geographical locations between the travel origin and travel destination. The method steps further include calculating, delineating, and displaying on the computer display a travel route between the user travel origin and travel destination via the user-selected waypoints of interest according to user choice of the shortest travel route, quickest travel route, or user-selected preferred travel route.

Brief Summary Paragraph Right (48):
The method proceeds by selecting a region of interest to the user along the user-defined travel route, and defining the region of interest by user-defined dimensions limiting excursions on either side of the user-defined travel route. The method uses a database of geographically locatable points of interest in the geographical areas of the electronic maps. The POIs are organized into a plurality of types for user selection of POIs by type. The POI types provide overlays of the CARPS database for display over the electronic maps on the computer display. The database also includes the travel information selected from the group consisting of graphics, photos, videos, animations, audio information and text information about transportation routes and waypoints of the electronic maps and points of interest of

the CARPS database.

Brief Summary Paragraph Right (49):
According to the method, further steps include identifying in the digital computer the transportation routes, route intersections, and waypoints of the electronic maps, corridor of interest selected by the user, and the POIs of the first database, by coordinate locations in a common geographical coordinate system; selecting specified POI types in the user-defined corridor of interest along the user-defined travel route and selecting particular points of interest from the selected types in the corridor; and assembling and displaying on the computer display a user customized travelog for preview of the user-defined travel route, said travelog including travel information in the database on the transportation routes and waypoints of the electronic maps and selected POIs in the user-defined corridor of interest along the user-defined travel route.

Brief Summary Paragraph Right (50):
The invention also contemplates steps of changing the user-selected travel origin, travel destination, transportation routes, or intermediate waypoints; recalculating, delineating, and displaying on the computer display a revised travel route; and assembling and displaying on the computer display a revised user customized travelog for previewing the revised travel route.

Brief Summary Paragraph Right (51):
According to another feature of the system and method, points of interest selected by the user within the user-defined region of interest along a user determined travel route can be converted to waypoints. This may be accomplished via a GPS receiver by which a user records waypoint data in the field for subsequent downloading to the CARPS desktop platform. The travel route is then modified to incorporate the selected points of interest as actual waypoints in a new or revised travel route. The selected POIs then have a new status in the proposed travel plan. Rather than merely possible destinations reached by side excursions from the designated travel route, they actually become waypoints on the travel route. The routing algorithm or routing procedure of the CARPS software therefore determines the shortest route, quickest route, or user-defined preferred route through the selected POIs as waypoints on the travel route.

Brief Summary Paragraph Right (52):
An advantage of CARPS is the availability of an array of multimedia information for points of interest and places in an area of interest. A user can therefore initially browse through the available information before even attempting an initial route. The array of multimedia information can then provide a basis for selecting an initial route with destination and waypoints. Once establishing an initial route the user can then follow the interactive and iterative procedures of CARPS.

Drawing Description Paragraph Right (2):
FIGS. 1B-1M, 1O and 1P illustrate example screen displays and user interfaces for CARPS while FIG. 1N illustrates an example hard copy printout of a travel plan prepared by CARPS.

Drawing Description Paragraph Right (6):
FIG. 5 is an example of a map display presented to the user on a monitor display by CARPS.

Drawing Description Paragraph Right (7):
FIGS. 5A, 5B and 5C are simplified screen displays showing alternative strategies and methodologies for circumscribing points of interest within respective defined areas of a selected travel route.

Detailed Description Paragraph Right (2):
Included for use with CARPS 100, a GPS (or similar geocoding) device is shown. An GPS/CARPS interface 105 between the GPS device and CARPS is provided to allow data transfer between CARPS and the GPS device. The GPS/CARPS interface 105 is preferably plug-in wiring. However, GPS/CARPS interface 105 may be any type of hardware that allows data transfer may also be used including wireless infrared data transfer devices, modem type of data transfer devices, and data transfer by intermediate memory

storage devices (e.g. diskettes, tapes, . . . etc.). The inclusion of the GPS/CARPS interface for use with the GPS device makes it possible for the CARPS user to record data with the GPS device at a location remote from the CARPS desktop embodiment for later download of the recorded data to CARPS. As well, data generated by the user with CARPS can be uploaded to a GPS device through the GPS/CARPS interface. Such uploaded data may be used for GPS guidance of the user along a CARPS-generated route. As well, the GPS receiver can upload real-time information on its current location for processing and display in CARPS.

Detailed Description Paragraph Right (3):
Alternative embodiments could include other input devices e.g. voice recognition system, joystick, touch-screen, scanner for printed map input, simplified keypad, etc., not represented here. FIG. 1A discloses CARPS 100 implemented on a single, stand-alone, desktop style, personal computer. The software technology, which facilitates interactivity between routing and multimedia, also works on a more portable laptop or notebook computer, a handheld personal digital assistant (PDA), embedded in a travel planning appliance or an in-vehicle navigation system, as well as on mainframes of various kinds, distributed work stations, or networked systems. Alternatively, users can also operate CARPS 100 from a remote interface through wireless or hard-wire links connecting with a distant computer system or a central service bureau.

Detailed Description Paragraph Right (4):
FIG. 1A shows a map book or set of printed maps typically on paper media 128 corresponding to the electronic or digital map 122 displayed on the screen or monitor 117. The printed maps 128 can be consulted as an aid in using the corresponding electronic or digital maps 122 displayed on screen, and the hardcopy travel plan printouts 126 derived from interactivity between the routing and multimedia elements of the invention. It is expected that users will printout such hardcopy travel plans 126 to guide and direct their journeys on foot, in vehicles, or by other means of travel.

Detailed Description Paragraph Right (5):
The hardcopy travel plan 126 illustrated in FIG. 1A consists of a strip map noting points of interest, travel directions and critical turning points along the recommended route, described in more detail hereafter. Such hardcopy travel plans, typically printed on paper, comprise a portable and compact form of output from the system, useful and easily read in field situations, without the expense or burden of carrying even a small computer device. A variety of other forms of digital and printed media output can result from the combination of the software routing and multimedia processes, as described hereafter.

Detailed Description Paragraph Right (6):
The user 103, in FIG. 1A, is operating both the routing and related multimedia elements of the invention. The monitor 117 screen is filled with an electronic analog map (or digital map) display 122 on which departure points, destinations and other waypoints can be entered or deleted and the shortest, fastest or otherwise optimized routes calculated, as described in more detail below. At the same time, in a multimedia window 120 superimposed upon the map display, the user 103 is engaged in viewing, hearing, or responding to a selectable, multimedia presentation related to points of interest and locations displayed on the underlying map screen 122.

Detailed Description Paragraph Right (7):
For purposes of this specification the term multimedia embraces all manner of graphics, text, alphanumeric data, video, moving or animated images, as well as still images, photographs and other audio or visual information in digital or analog formats. Multimedia also includes audio output options, voice, music, natural and artificial sound, conveyed to users through a speaker system 107 or earphones 108. As detailed hereafter, the invention stores, manages and retrieves a database of multimedia information in relation to specific places on or near the surface of the earth, referred to herein as points of interest (POIs), or geographical sites or locations. These are geographically locatable objects (loc/objects) for which multimedia information is available in the CARPS database. Generally, POI's can be represented in both digital and print media cartography and are situated or described by standard geographic coordinates such as latitude and longitude, UTM, State Plane,

or equivalent map location systems.

Detailed Description Paragraph Right (8):
From the digital map and routing function shown in FIG. 1A at 122, the user 103 can select one or more particular geographic locations, or points of interest (POIs), in order to view, hear or manipulate related information in the multimedia dimension of the invention. FIG. 1A shows the multimedia element of the invention as an episode in a multimedia presentation comprised of graphics or text, shown in an on screen window 120, or audio output conveyed to the user 103 via a speaker 107 or earphones 108. For example, in the multimedia window 120, the user 103 can view and selectively respond to color photographic or video images or related textual information about a specific location, or group of locations. Locations are chosen by the user working within the underlying digital map and routing dimension of invention, illustrated at 122.

Detailed Description Paragraph Right (9):
More specifically, FIG. 1A shows a scenario in which the user 103 has selected a particular lakeside location 124 on the underlying digital map, or in conjunction with a route or a waypoint along a route. The specific lakeside location 124 is shown as an "X" in a circle 124 on the simplified drawing of a typical digital map screen 122. The user 103 picked this point of interest located by a lake by means such as a mouse clicking operation at the location or placename as depicted on the digital map 122. The location can also be identified by words or symbols along a displayed route on the underlying digital map screen 122, by selection from a list of place names or from a list of types of locations, or by other routine or state of the art inputs.

Detailed Description Paragraph Right (10):
The user's choice of a particular location prompts a multimedia presentation 120 of information related to the selected place e.g. stills or video pictures of the lake, local events, places to stay or eat, attractions and recreational opportunities, related text or audio narrative, local history, lore, even complex or extensive data on topographic, environmental, demographic, real estate or marketing information, etc. The multimedia presentation is illustrated by the graphic image of a view of the lake, sailboat and mountains on the far shore, in the window 120, accompanied by related audio output 107 or 108. CARPS 100 enables a user to prompt a multimedia presentation 120 on a location 124, or group of locations, selected from within a digital or electronic mapping system 122, equipped to do routing functions and displays 123.

Detailed Description Paragraph Right (11):
FIG. 1A additionally illustrates procedures whereby users can modify waypoints and other route parameters from within the multimedia element of the software invention. Typically, routes or waypoints are displayed as highlighted line segments or points 123 on the digital or electronic map 122. Routes and waypoints may also take the form of map symbols and annotations, or of ordered lists of place names, travel directions, geographic coordinates or various other location identifiers, as described hereinafter. CARPS 100 combines routing and multimedia elements by enabling the user 103, to add, delete or insert one or more particular geographic locations or points of interest. This is achieved based upon the presentation of multimedia information about those locations, as new or modified input for additional processing of the route.

Detailed Description Paragraph Right (12):
For example, in FIG. 1A, mouse manipulable buttons along the bottom of the multimedia window 120 enable the user 103 to command CARPS 100 to include the lakeside location 124, based on the multimedia presentation 120, as new input for routing. CARPS 100 facilitates entry or deletion of locations, reviewed in multimedia subject matter, as new starting places, destinations, intermediate waypoints, or points of interest along the way as part of the user-selected route. FIG. 1A represents how user interactions with multimedia about locations can be used to change the route. FIG. 1A further illustrates output from CARPS 100, a hardcopy printout 126, typically a customized or individualized travel plan in the shape of a strip map annotated with travel directions and related information. Output from CARPS 100 is produced by combined interaction between the routing functions and user responses to the multimedia information about particular geographic locations. Thus, for one example, the hardcopy travel plan 126 exhibits attached points of interest, typically in the form of annotations connected with graphic arrows or pointers to particular geographic locations which fall within a predetermined distance from a displayed route. The user

attaches such points of interest to a digital map route display from a multimedia presentation on those locations. Alternative forms of digital, audio, text, graphical, hardcopy or multimedia output from CARPS 100 are detailed later in this disclosure.

Detailed Description Paragraph Right (13):
Output from the invention can result from a single, simple interaction between routing and multimedia elements. FIG. 1A illustrates a scenario whereby the user-selected only one point of interest, a place by a lake 124, close to a route 123 highlighted upon an electronic or digital map display 122. Next the user prompted the presentation of multimedia information in a window 120 concerning the lakeside point of interest. Prompted by the multimedia presentation, the user then pushed the "Attach" button in the command bar across the window bottom, or otherwise prompted CARPS to include the lakeside location as an annotated point of interest within a specified distance from the highlighted route displayed upon the map screen or printed on a hardcopy travel plan.

Detailed Description Paragraph Right (14):
In FIG. 1A, the hardcopy travel plan 126 output actually contains arrows or pointers from three annotation boxes to three corresponding points of interest attached to the strip route map output. Moreover, the highlighted route running up the center of the strip map format may reflect waypoints added or deleted over the course of a sequence of interactions between the multimedia and routing elements of the invention. Users can utilize the invention to attach multiple points of interest, or make many modifications of actual waypoints and highlighted routes, working interactively between the multimedia database and the routing function. The system, as described hereafter, is flexible, selective and capable of series of multiple interactions and repeated iterations in order for the user to develop, alter and refine an individualized or customized travel plan through varied operational cycles, combining routing and utilization of the multimedia database on locations.

Detailed Description Paragraph Right (16):
FIGS. 1B through 1P are screen captures from MAP'N'GO (TM) 1.0 by DeLorme Mapping, Freeport, Me. 04032. MAP'N'GO 1.0 includes an auto road atlas of North America both on CD-ROM and printed in a companion paper map book. The MAP'N'GO 1.0 CD-ROM contains a travel planning software utility embodiment of the present CARPS invention. This utility enables users to generate digital or hardcopy travel plans from routing operations and selected audio, text and pictorial information on hotels, restaurants, campgrounds and tourist attractions.

Detailed Description Paragraph Right (17):
FIG. 1B reveals the basic user interface, including a map display, and diverse user options for manipulating the electronic maps. Three buttons with diagonal arrows in a row at 130 enable the user to zoom in or out among map scales. Nine buttons in the form of a compass rose at 131 cause the electronic map display to shift or pan to center on a new latitude and longitude. At 134, an overview screen shows the area depicted on the main map in a rectangle in relation to surrounding geography. Mouse clicks in the rectangle further enable the user to shift or pan the center of the map to a different location on the earth's surface. Page numbers and grid identifiers are indicated at 132 for coordinated use of companion paper maps. At 133, the main map scale is shown in terms of "mag" or "magnitude" such that mag 10 offers a closer typically more detailed view than mag 8 or 6, which each present increasingly distant perspectives or map coverage of larger parts of the earth's surface.

Detailed Description Paragraph Right (18):
FIG. 1C also reveals the basic user interface, including a higher magnitude or closer scale map, as shown at 135. Compared to FIG. 1B, FIG. 1C offers a main electronic map display with more detail including geometric symbols in small rectangles under "Seattle" for example. These symbols represent the availability of supplemental travel information on specific types of locations e.g. Hotels, Campgrounds, Restaurants and Points of Interest. One such symbol indicating a real-time or recorded location as sensed by a GPS receiver interfacing with CARPS is shown at 136a. As disclosed hereafter, the user can access and manipulate the added multimedia travel information by various mouse or keyed commands.

Detailed Description Paragraph Right (19):

FIGS. 1D, 1E and 1F illustrate assorted locating tools for finding geographic locations, recentering the electronic maps, and selecting specific places or geographic loci as input for routing or multimedia operations. Three buttons in the row at 136 prompt the dialog boxes for "Locate Place Name" at 137, "Locate Zip Code" in FIG. 1E and "Locate Area Code and Exchange" in FIG. 1F. This suite of locating tools facilitates searching lists by the names of places or cities and respective states or provinces as well as locating specified places by recentering the map display upon the identified location.

Detailed Description Paragraph Right (20):
FIGS. 1G, 1H, and 1I express the interface for routing and related operations. The user can access the Manage Route menu or dialog box at 138 by depressing the Route button at 140. A quick pull-down menu at 139 also makes routing or related options available. The user can enter a starting place, e.g., Montpelier, Vt., and a final destination, e.g., Plattsburgh, N.Y., plus intermediate, optional waypoints in between if desired. A suite of buttons at 141 enable the user to add, insert, delete, etc. items to or from the waypoint input list by routine text and graphic input means. Entered waypoints are symbolized on the map interface by numbered inverted triangles as shown at 147. The user prompts calculation of optimal routes by selecting between Quickest, Shortest or Preferred options at 143 or the 139 quick menu. The resulting route is displayed by highlighting the recommended roads on the map display as shown at 146 from Montpelier through Burlington to Plattsburgh. Added control over routing parameters or variables is provided by depressing Speed 144 and Prefers 145 buttons which access dialog boxes for adjusting the routing computation. The FIG. 1I dialog box allows the user to modify estimated or anticipated speed, or rate of travel, in miles or kilometers per hour for various road classifications. The FIG. 1H dialog box enables the user to calibrate the routing computation module to favor or avoid specified types of roads.

Detailed Description Paragraph Right (21):
FIGS. 1J and 1K further depict routing functionality plus introduce multimedia capabilities. Accessed for example through the 139 quick menu in FIG. 1G, the Points of Interest Along the Way dialog box at 148 in FIG. 1J exhibits a list of three items termed POIs for points of interest in this disclosure. By prompting the Along the Way command, after inputting an ordered list of waypoint input, the user has caused the software to seek and find POIs within a specified distance from the computed route for which further information is available in the form of audio, pictures or text. By depressing either the Show/Tell All or the Show/Tell One buttons on the right in the 148 Along the Way dialog box, the user can prompt a multimedia presentation or series of presentations as shown at 151 in FIG. 1K. Controls along the bottom of the 151 picture display window on Burlington facilitate user control and selection of multimedia content and form, as described hereafter. In FIG. 1J, the Attach button on the right in the 148 dialog box enables the user to pick, fix and include selections of information with travel plan output, as disclosed further hereafter. Travel Plan dialog or list boxes are shown at 149 in FIG. 1J and 152 in FIG. 1K. Travel Plan list boxes are a form of routing computation output including a list of waypoints, routes, compass directions, nearby town, time and distance estimates for route segments and the overall route.

Detailed Description Paragraph Right (22):
FIG. 1L and 1M further depict information resources about specific types of places. As disclosed hereafter in relation to FIG. 1-0 and quick menu 161, the user can access information on specific types of POIs such as hotels or restaurants. List boxes for local hotels and restaurants appear at 154 and 156 in FIG. 1L and for campgrounds at 158 in FIG. 1M. These listboxes all have a button to Attach information on chosen accommodations to emerging travel plan output. These listboxes also allow the user to call for more detailed information or Full Info on selected locations of the respective types. Such information availability is indicated on the mapping interface by colored symbols within a small rectangle under or adjacent to the relevant place name, as shown for Shelburne at 157. The Campground information box at 159 shows a typical display of Full Info requested by the user concerning the Shelburne Camping Area.

Detailed Description Paragraph Right (23):
FIG. 1N illustrates a typical, moderately complex MAP'N'GO (TM) 1.0 hardcopy travel

plan output, as developed in FIGS. 1G, 1J and 1K. Note the heading up orientation of the travel plan, with point of departure at the bottom and destination at the top of a strip map format, as compared with the conventional North is Up and South is Down orientation of the map display in FIG. 1G. The heading up strip map format of the FIG. 1N travel plan has the advantage of a mapping representation in which a route change involving a righthand turn e.g. in Burlington appears intuitively as a righthand turn on the travel plan map. The FIG. 1N travel plan illustrates text travel directions and travel time estimates in hours and minutes along the right margin. Pictorial and text attachments plus estimated miles of travel are presented in the left margin and border of the FIG. 1N strip map.

Detailed Description Paragraph Right (25):
As shown in FIG. 1P, flexible control over multimedia form and content enables the user of an in-vehicle embodiment of the invention, for example, to maintain an output of audio 169 travel directions for the driver to hear. Meanwhile, the passenger can monitor the visual route map at 170 and, at the same time, browse through information about places to eat in Seattle using the restaurant list box 171. For in-vehicle use, alternatively or in addition, a GPS receiver linked to CARPS can provide a display of the vehicle's current position as shown as a "blinking" dot at 173.

Detailed Description Paragraph Right (26):
FIG. 2 is a block diagram illustrating an interactive system 200 which combines computer software processes for routing and travel directions with presentations of multimedia information related to locations. CARPS works with one or more geographic information systems (GIS) 201 for storage, retrieval, manipulation, mapping, correlation and computation of spatial data related to geographic coordinates corresponding to locations on, above or beneath the surface of the earth within the realm of human activity. The David M. DeLorme U.S. Pat. Nos. 4,972,319 and 5,030,117, exemplify such geographic information systems for generating the map displays and output, as well as management of the geographic databases. Other GIS, or other database systems which relate data with geographic coordinates, e.g., latitude and longitude, also suffice for use with the present invention.

Detailed Description Paragraph Right (28):
Processing starts either with routing 203 or multimedia 204. For example, as a leading step within the routing subsystem 205, a typical application, or episode of use, proceeds with waypoint input 231, typically selected by the user, including a starting place, a final destination and optionally one or more mid-points or intermediate locations where the user may stop or pass through in his or her travels. Waypoints include departure points and destinations as well as intermediate or mid-route waypoints. Waypoints are listed in the users intended order of travel. The system 200 facilitates waypoint input for routing functions by a variety of means, including database searches, as disclosed for input of points of interest (POIs) within the multimedia block 209. Waypoint input can also be derived from a GPS receiver interfacing with CARPS, for example, to download the current position of the GPS receiver and input it as a starting point.

Detailed Description Paragraph Right (30):
Based on user-optimized route computations, step 259 next expedites one or more computer displays, graphics, hardcopy, text, audio or other output, representing the initial route as computed along the waypoints input by the user. Such routes are represented as various forms of itinerary including: (1) annotated maps upon which the optimal routes are graphically marked, accentuated or highlighted; (2) lists of waypoints, or place names or geographic coordinates typically arranged in the order encountered along the route; (3) point to point directions how to take the optimal computed route indicating turning points, landmarks, navigation aids, signposts etc. along the computed route also typically arranged in temporal order of travel; (4) one or more POIs or preferably one or more ordered sets of waypoints or route nodes electronically uploaded into a compatible GPS receiver (interfacing with CARPS as detailed relative to FIG. 1A) for route guidance in the field; (5) various combinations of the four forms of route output or itinerary just listed.

Detailed Description Paragraph Right (31):
As pictured in FIG. 1N, the preferred route output includes map displays or map hardcopy with the optimal route highlighted, marginal travel directions in an easy to

follow format with the point of departure consistently at the map bottom, and the destination near the top of the strip map format. Alternative embodiments express such route information output in pure form at step 259 in FIG. 2, by employing other graphics or map formats, images, text and numbers, or sound/voice output to convey the recommended or optimal itinerary or route.

Detailed Description Paragraph Right (32):
On the other hand, a typical operation or program can begin on the multimedia side 209 with user entry of one or more points of interest (POIs) selected by the user inputting individual POIs or by database searches, sorting for specific predefined types of POI, related characteristics, or linked data or information using the underlying GIS 201. In FIG. 2, to set up a presentation of multimedia place information, the user can perform individual or manual POI input at step 243. For example, a vacation traveler can request multimedia information on two or three popular resort locations recommended by friends, ads or travel articles by using well known data entry methods such as keying in the resort names, or nearest place name, or geographic coordinates. The system 200 is further able to locate individual POIs for input by enabling a user to select from lists of place names, or through linked phone exchange, zip code or geographic coordinate data. The user can engage in manual input of individual POIs by clicking at points, symbols or place names on the map display.

Detailed Description Paragraph Right (38):
The overall system 200, however, enables transfers of intermediate and final outputs between the independent routing 205 and multimedia 209 processes or subsystems. Multimedia and pure routing functions, as just discussed, are blended or integrated essentially by sequencing multimedia and routing operations under user control. Routing 205 plus multimedia 209 subsystem operations, performed sequentially, produce combined or interactive output at step 265. The combined or interactive output typically includes a unique, customized or personalized travel plan provided in the form of map displays or hardcopy maps annotated with information about places, and travel directions, with the optimal computed route highlighted, labelled or otherwise marked. Users can opt to further embellish combined, interactive travel plan output with selected multimedia graphic images, videos, animations, sound or voice output as well as text, documents, numeric or tabular data about locations, POIs or points of interest or other geographic objects along the way, i.e., on or near the computed optimal route. One preferred form of such combined travel plan output is illustrated in FIG. 1N.

Detailed Description Paragraph Right (39):
Combined interactive output 265, typically an ordered set of waypoints related to an optimum route and limited POI information, can be uploaded into a compatible GPS receiver interfacing with CARPS. User interaction with routing and multimedia, as illustrated at step 265, gives a combined interactive output that reflects choices made by the user. Step 265 output integrates the user's decisions about waypoint input or routing calculation parameters, plus the user's selection of individual POIs or multimedia inputs derived from database searches, along with the user's interaction with and responses to multimedia presentations. For example, in order to revise or refine his or her emerging itinerary, the user can modify an initial route by altering the current waypoint list adding places he or she really desires to visit, or excluding places from the itinerary, in response to selected multimedia information about the locations found along the initial route. The system 200 further enables users to attach or include multimedia selections to or with travel plan output, i.e., printouts, audio, screen displays, etc. As shown at 265 in FIG. 2, combined output incorporates the user's choices and interests as exercised through one or more interactions with and between the routing 205 and multimedia 209 subsystems.

Detailed Description Paragraph Right (41):
As disclosed in detail hereafter, various input/output transfers and combined routing/multimedia operational sequences take place through the interaction bus 237. Within the middle block 207, the interaction bus 237 facilitates repetitive, looped or iterative operations as well as user interactions producing combined output at step 265 by sequencing multimedia and routing operations. For example, the system 200 enables users to blend pure routing output generated at 259 with subsequent multimedia operations by transferring data via path 261, the interaction bus 237, and path 241 to the multimedia input step 243. In this manner, users can prompt a multimedia

experience of information focused upon places found along the way, i.e., within a preset distance of, or in a user-defined region around, an initial route or set of waypoints. Thus in typical operations, the invention 200 sequences prior routing and subsequent multimedia operations to generate route based multimedia information presentations on locations or points of interest along an initial route. Output 259 from prior route computations gets transferred from block 205, the routing subsystem, through the interaction bus 237, over into the multimedia subsystem 209 which then absorbs the route data as, multimedia input at step 243. The user can then pick and play one or more multimedia presentations about points of interest or geographic locations found in the vicinity of the current optimal route highlighted on the map display.

Detailed Description Paragraph Right (48):
As detailed hereafter CARPS 200 enables even more complex operational chains and loops, typically because the user is engaged in replaying selected routing and multimedia steps or operations, usually with minor or modest variations of inputs and parameters, in an effort to refine his or her travel plan. Complex operational sequences also occur because the user shifts back and forth repeatedly between routing and multimedia tasks, for example, to play multimedia information related to routes and waypoints appearing on the map display, or to revise their travel plans by altering the current list of waypoints in response to multimedia information about places and POIs.

Detailed Description Paragraph Right (50):
The user can opt for a quick and simple routing operation or extensive travel planning with multimedia input. For example, a user can employ the system 200 just to input Boston as a point of departure and New York as a final destination, then compute the quickest route for automobile travel between the two cities. Given more leisure time, however, the user can elect to proceed with the invention 200 to experience multimedia about points of interest around the quick car route to New York from Boston, or to explore and compare rail, air or marine routes between these two cities. Moreover, in response to the multimedia experience, this user can plan various side trips, or a much more convoluted route incorporating intermediate waypoints, including places the user wants to visit.

Detailed Description Paragraph Right (52):
After making an extensive travel plan, including more side trips or stopovers than available leisure time, the user can opt to edit or revise down an overambitious travel plan. This task of prioritizing or selectively reducing a travel plan entails yet another series of multimedia presentations and routing computations, aimed at the discriminating elimination of the intermediate destinations of least interest to the user, and the side trips or modes of transportation which involve too much travel distance or travel time. This disclosure employs the shorthand notation explained above in order to help express or describe such complicated sequences of multimedia and routing operations in relation to the FIG. 2 block diagram, or more detailed flow charts presented hereafter.

Detailed Description Paragraph Right (53):
Importantly, the shorthand notation aids the user in understanding that the invention 200 facilitates a diversity of repeated or combined software operations. The interaction bus at 237, within the interaction block 207, enables pure sequences of iterative operations e.g. a series of routing operations only, as well as sequential combinations of mixed multimedia and routing operations. By talking or following different paths through the interaction block 207, for example, the user can either recycle a pure routing operation, with deliberate variations, or combine antecedent routing output with subsequent multimedia operations to produce presentations of information in various media related to the prior routing output. Vice-versa, the user can repeat a pure multimedia operation varying significant details. Or the user can invoke an ensuing routing operation, after a multimedia presentation about locations or geographically located objects, typically in order to plan and map out optimal travel routes and transport between selected places or points of interest experienced by the user in the multimedia.

Detailed Description Paragraph Right (60):
For example, the user might proceed to compute an optimized route from home to the one

resort location most preferred by the whole family. This entails transfer of POI data on the selected resort from the multimedia subsystem 209 into the waypoint input module 231. There the user can input the resort location, or the nearest routable node, as the ultimate travel destination. The user's home address is entered as the point of departure. Then, in step 245, the user can prompt the computation of the quickest, shortest or another optimized route, as detailed hereafter. In combination with prior multimedia tasks developing a short list of resorts, this one simple follow-up routing computation expands the overall formulation to the following: MI, M2, M3, RI=C01. The first three multimedia operations can also be expressed in terms of their pure output M03, which the user can elect to save for later comparison and/or added processing. Thus, the overall sequence of combined routing and multimedia can be equivalently and compactly formulated as: M03, RI=C01. In any event, C01 stands for a combined output rather than pure output. Following up the antecedent multimedia selection of resort locations, the routing operation R1 proceeds by way of steps 245 and 257, then path 247, through the interaction bus 237, down path 263 to step 265. There it becomes the COI combined output, typically in the form of highlighting the optimal computed route from the user's home to the selected resort on the underlying map display.

Detailed Description Paragraph Right (64):
Along with the capability to modify multimedia and routing parameters and content, the invention 200 provides user control over operational sequencing and combinations, facilitating the production of individualized, custom, or personal travel plans. This disclosure uses the terms "individualized," "customized" or "personalized" to characterize output generated with substantial user interactivity. Even in the example previously cited, where the user only opts to compute the quickest automobile route from Boston to New York City, the user exercises choice over the point of departure and the travel destination. More user interactivity productive of custom output is illustrated by the added selection of intermediate waypoints, such as Hartford Conn. and Providence R.I., and the specific order of travel between waypoints. User choices or interaction are also enhanced by the capability for comparison of varied routing parameters e.g. scenic or shortest route and varied modes of transport e.g. rail, bus, ferry, air as well as automobile travel. The invention further enables individualized or custom output by facilitating unique iterative, sequenced and combined multimedia or routing operations, according to the user's responses and preferences while operating the system 200.

Detailed Description Paragraph Right (65):
Customizing travel plans through the selective exercise of user controls over the sequencing and combination of operations was already exemplified above in the case of the resorts picked first in the multimedia subsystem 209. The user could proceed thereafter with various scenarios for follow-up routing tailored to user requirements and preferences. Comparing and evaluating alternate destinations and routes enabled the user to develop or refine individualized travel plans, reflecting "roads not taken" or selectively deleted waypoints as well as explicit travel information. Such customized travel planning often entails some operational sequences being repeated with the user varying the format, content, media and parameters involved in succeeding operations. Such systematic variations help the user to decide about alternative waypoints, transport, points of interest, or variable informational forms and content, in order to compose a personal travel plan. Travel planning is typically individualized by the user controlling transfers and integration of data between the multimedia 209 and the routing 205 subsystems by means of user selectable pathways through the interaction bus 237. For instance, individualized travel plans are further facilitated by operational sequences, commencing in the routing subsystem 205, which are then combined with follow-up presentations in the multimedia subsystem 209.

Detailed Description Paragraph Right (67):
FIG. 2 depicts the flexibility or user options as provided by the invention 200 for variable or custom sequences of routing and multimedia operations. For one instance, having done no more than enter Boston as the starting point plus New York City as the final destination in the waypoint input module 231, the user can choose to transfer operations and data via paths 233 and 241, and prompt multimedia presentations on the attractions, accommodations and other geographically located information about Boston or New York City, which are stored in the CARPS database. This option is further described in relation to FIG. 4, particularly step 431. Alternatively, the user can

opt to transfer to the multimedia 209 only after computing and displaying an optimal route from Boston to New York through steps 245 and 259 in FIG. 2. Then, paths 261 and 241 enable access to a variety of subsequent multimedia about Boston, New York City, or points of interest or POIs found along or within a certain user-defined region around the optimal route. FIG. 4 especially step 471, FIGS. 5, 6A and 6B, and related text, further specify this process whereby POIs are found or located along the way or within a user-defined distance from a computed route or its component waypoints. In sum, the sequences of operations discussed in this paragraph generally reduce in the shorthand notation as follows: R1, M1=CO1. The one multimedia operation, following one prior substantial routing computation or waypoint input operation, logically generates combined output 265 via path 251, the interaction bus 237 and path 263.

Detailed Description Paragraph Right (74):
FIG. 3 is a flow chart illustrating the organization and procedural logic of the commands or user options available to multimedia users of the preferred embodiment of CARPS. The system combines multimedia and routing to provide a software utility for personal and business travel planning. FIG. 3 depicts data transfer pathways as well as the hierarchy of commands and user options available to users in the Points of Interest system listbox or dialog box shown in FIG. 1J. In the multimedia mode, the user can call up this dialog box on top of the map display which typically dominates the computer screen.

Detailed Description Paragraph Right (78):
Either to start a fresh pure multimedia presentation or to modify one or more preexisting POI lists, the user proceeds from C to step 319 in order to get and decide on POI inputs in several ways. Users can get and manually enter one or more POIs typing in place names, geographic coordinates or other literal location indicators. The user can also seek, pick or delete POI input by browsing lists of locations, or other situated data, and choosing points of interest. Moreover, the user can employ cartographical or graphic means in order to locate potential POIs to be added to or deleted from the current POI input list. This typically is done by positioning the cursor on locations, symbols, geographic coordinates, place names, etc. on the current map display. The user can manipulate the cursor position on the map display with the mouse, arrow keys or other means in order to recenter the map display, causing it to shift or pan laterally to a new location centered on a different latitude and longitude. In summary, the "GET POI" operations at 319 include user options to add, delete and rearrange the POI input list along with shifting or recentering the map display on the current POI.

Detailed Description Paragraph Right (79):
Users can also opt for zooming down to a closer map scale for a more detailed perspective or zooming up or out to get a more global outlook covering larger territory. CARPS utilizes such flexible and intuitive capabilities to zoom among map scales or shift across digital maps, seeking POI input, with map generation and cartographic database technology as disclosed in the David M. DeLorme U.S. Pat. Nos. 4,972,319 and, 5,030,117. The user can also shift, or recenter, map displays to locate POI inputs by entry of telephone numbers, zip codes, street address information and other located or locatable data. CARPS provides several textual or graphic methods for the user to get POI input by means of selective commands and procedures made available at step 319. The system also enables the generation and modification of lists of POI inputs by various methods for database searching and sorting well known in the art of computer programming.

Detailed Description Paragraph Right (86):
At 309, in FIG. 3, the user develops or alters his or her travel plan or itinerary by attaching selections of multimedia, as experienced in a Show/Tell operation. Such travel plans or itineraries are composed in CARPS in part by the attaching of multimedia information about places and locations to the underlying map display on which is highlighted previously computed optimal route output. FIG. 1N illustrates one example of such travel plan output, adorned with annotations, pictures, and graphic arrows concerning points of interest as selected by the user in response to multimedia presentations on those locations or POIs, generated by CARPS preferred embodiment. Different, more advanced embodiments facilitate attachment and location of audio or video output, experienced in the multimedia mode, on digital travel plan outputs combining multimedia and routing as detailed elsewhere in this disclosure. Step 309

enables the user to transfer selected multimedia through M to be attached to an itinerary or travel plan, as depicted in FIG. 1N, by processes described hereafter in relation to FIG. 4.

Detailed Description Paragraph Right (87):
In the lexicon of this disclosure, attaching multimedia refers to the process of picking, transferring and displaying multimedia about particular POIs or locations through the interaction block 207 for inclusion upon travel plan output at 265 with reference to FIG. 2. Attached multimedia can comprise text annotations about POIs with graphic arrows or pointers indicating the site or geographic location of specific POIs on travel plans in the form of map hardcopy or map display output on which one or more routes are highlighted, as shown in FIG. 1N. Other embodiments enable attachment of still or moving images, sound, and various other media to travel plan output. Though such multimedia attachments invariably modify the informational content of travel plans, the definitive feature of travel plans with attached multimedia is that the highlighted computed optimal routing component has not been altered by modification of the waypoint lists.

Detailed Description Paragraph Right (94):
FIGS. 4A, 4B, and 4C are assembled to form the flow chart referred to hereafter as FIG. 4. FIG. 4 is a flow chart illustrating the processes and user options included in the routing mode of a preferred embodiment of CARPS. The system is a component software travel planning tool which combines multimedia and routing. FIG. 4 relates to the operational sequences, data transfers and user controls implemented by way of the Manage Route dialog box depicted at 138 in FIG. 1G. The user can access this suite of tools, commands and processes, invoking the routing mode of operations, by calling up the Manage Route dialog box on top of a portion of the map display which pervades the computer screen in typical applications of the system.

Detailed Description Paragraph Right (98):
In FIG. 4, steps 406 and 409 mean that the user can opt to exit from or close the waypoint input module. Like virtually all operations embodying the invention, waypoint input is achieved on top of a computer map display, which becomes part of the waypoint input interface, as described hereafter. In the lexicon of this disclosure, waypoints are route input items including one point of departure, one final destination and, optionally, one or more intermediate loci entered in order of travel. Waypoints are highlighted as input with inverted green triangle symbols on the map display as shown at 147 in FIG. 1G. As entered, waypoints also appear on a list in the order to be encountered on the intended journey, as shown in the Manage Route dialog box illustrated at 138 in FIG. 1G. The list of waypoints arranged in planned order of travel in the Manage Route dialog box corresponds to step 411 in FIG. 4. The user works in the waypoint entry module or command suite until he or she elects to close the function at 406 and 409, or to compute a route at 433, or to transfer waypoint input through 431 in order to experience selected multimedia information about the waypoint locations and nearby places.

Detailed Description Paragraph Right (99):
Consistent with methods for the management of ordered lists well known in software, the module for waypoint input enables the user to add one or more waypoints to the end of the waypoint list at 413, clear all waypoints at 415, or delete one or more waypoints, at 417. Routing requires at least a starting place and a destination, i.e., at least two waypoints. Step 419 recycles empty or single item waypoint lists for further input to meet this requirement. Step 421 facilitates the insertion of one or more new waypoints at places chosen by the user between or before other waypoints on a preexisting list. In this way, the user can amend a waypoint list starting out from Boston going to New York City by inserting Hartford en route. Or, the user can insert Los Angeles or Mexico City as intermediate stops or places to pass through on his or her planned trip departing from Boston and ending in New York City. After specific waypoints have been cleared, deleted or inserted, steps 423 and 425 implement those changes by rearranging the current waypoint list in accord with the user's revised or amended order of planned travel.

Detailed Description Paragraph Right (100):
Even entry of a fresh waypoint list can cycle several times through H while the user is engaged in revising his or her initial input. Moreover, the waypoint entry module

also enables the user to edit and alter a waypoint list from which an optimal route has already been computed and displayed. In such cases, a user adds, deletes or inserts waypoints relating to a previously computed route. Then steps 427 and 429 function to clear away the old route display, anticipating a new route computation which will incorporate the user's new waypoint list based on revision of the old waypoint list.

Detailed Description Paragraph Right (101):
The system enables input and alteration of waypoint lists by means of an array of list based locating tools that can search zip code, phone exchange and place name indexes, as shown in FIGS. 1D, 1E and 1F. The map display recenters on new locations thus selected by the user. Also, the user can employ graphic/cartographic means for the selection of waypoints and related manipulation of the map display. For an example, users can choose waypoints by pointing and clicking upon symbols or place names or at specified pixel locations on the digital map display which correspond to geographic coordinates of places or objects situated on or adjacent to the earth's surface. Graphic, intuitive waypoint input location is further facilitated by capabilities to zoom amongst map scales and detail levels as well as panning or shifting to recenter the map display upon a different place or set of geographic coordinates.

Detailed Description Paragraph Right (102):
In alternate embodiments of CARPS and enhanced commercial versions, routing or waypoint input can encompass airports plus flight paths, bus stations and bus routes, railroad terminals and tracks, subways and other urban transit systems, off-road vehicle travel, trails for bicycles, hiking and other pedestrian paths as well as oceanic, coastal and inland shipping channels, also boat launches, portages and river passages for canoes or rafts, plus other commercial and recreational transport and travel means. Even more generalized point-to-point routing more or less "as the crow flies" over rasterized or digitized computer maps can be added. The present system is applicable to a broad range of point and vector data structures familiar in the routine arts of geographic databasing and digital cartography including but not limited to the foregoing specific input/output formats for waypoints or POIs as detailed in relation to FIGS. 5, 6A and 6B.

Detailed Description Paragraph Right (103):
The system technology is designed to take user travel planning requirements into account. Waypoint inputs are ordinally structured. First on any waypoint list is a single point of departure. By definition, waypoint lists end with one final destination. In between, stops and places to pass through picked by the user are arranged in the order of intended travel. Thus, a first waypoint list consisting of Boston, Hartford, New Haven and New York City is not the same for, example as a second waypoint list which calls for leaving Boston, going to New Haven, then Hartford, on the way to New York City. Waypoints are input in an ordinal or serial data structure which is a representation of the user's intended order of travel: (1) first, the starting place; (2) second, initial intermediate waypoint; (3) third, next stop or waypoint; N-1th intermediate waypoint; and Nth waypoint, final destination or end of planned journey. Intermediate waypoints are optional, of course, but get entered in a specific order corresponding to the user's intended itinerary. Even before any computation of the optimal routes between a set of waypoints, waypoint input is already arranged in a data format descriptive of the user's overall planned itinerary.

Detailed Description Paragraph Right (105):
This disclosure confines the term routing output to output from computation and display operations at steps 433 through 453, as detailed hereafter. Waypoint input operations, transferred to multimedia via step 431, still qualify nonetheless as substantial routing steps or operations for purposes of making up a valid set of routing and multimedia operations combined in sequence within the inventive technology. This is because ordinally structured waypoint input can be distinguished from random location data, or even from a list of POIs selected manually by the user or from a database search based on personal interest or links to specific topics or subject-matter. Waypoint input describes the user's point of departure, planned stop-overs or intermediate waypoints and ultimate destination in order.

Detailed Description Paragraph Right (108):

Similarly, service and delivery personnel can plan their work for the day or the week on the road. Appropriate databases can help identify prime properties or security trouble spots. Real estate or security agents can input the street addresses or other location identifiers from the database in order to compose a waypoint list as input for the computation of an optimal route encompassing the properties of interest to the agents. With the waypoint list at step 411 and the background map display, alternate embodiments of the invention incorporate a variety of well-known databasing methodologies in order to enable the user to design, implement, output and further process diverse searches for waypoint input. In like fashion, waypoint lists can be memorized and recalled for later use or modification.

Detailed Description Paragraph Right (109):
Step 411 and the map display interface also facilitate the processing of canned or prepackaged sets of waypoint inputs in addition to individual ad hoc waypoint input lists made by users planning personal travels in the waypoint entry module. Thus, the present invention enables processing by the user of prepared lists of particular types of museums or recreational facilities, for example, with database links to the pertinent street addresses or other location identifiers such as latitude/longitude. The user may purchase such digital lists of potential waypoints on software media e.g. diskette, CD-ROM, PCMCIA cards etc. as a data accessory for use in the system. Such prepackaged lists of waypoint inputs can also be downloaded via modem from another computer or a central service bureau. Such pre-recorded lists include sets of business or residential names and addresses linked to certain financial or demographic data. Alternatively, an off-the-shelf travel plan might include a recommended list of waypoints for a selected region or user interest. Utilizing the waypoint entry module, the user can then modify or personalize and customize such prerecorded waypoint lists. To assist with the task of individualizing a canned list, the user can invoke step 431 to consult selected multimedia information concerning the predefined waypoints, nearby resources and attractions.

Detailed Description Paragraph Right (111):
For example, the July 1994 release of the MAP'N'GO (TM) 1.0 on CD-ROM included a preferred embodiment of the invention, in the form of a travel planning utility, which computes quickest, shortest, or other preferred or optimal routes along major auto roads and selected car ferries. This embodiment represents the available routes as certain line segments on map displays which are drawn between the routable geographic points generally termed "nodes". The MAP'N'GO (TM) 1.0 travel planning utility treats the following geographic points as possible waypoints or nodes: (1) major road and highway intersections; (2) the junctures or turning points of connected line segments representing the major auto roads and highways; (3) place names situated right on major auto roads and highways; and (4) POIs located on or immediately adjacent to the major roads or highways. To facilitate and speed routing computations in this embodiment, every possible waypoint or routable node is stored in the CARPS database on the CD-ROM in association with a list of all immediately adjacent nodes and the precalculated distance thereto. The July 1994 MAP'N'GO (TM) 1.0 travel planning utility computes optimal routes between selected and ordered lists of nodes or waypoints employing routines based on the Sedgwick-Vitter algorithm disclosed in James A. McHugh, Algorithmic Graph Theory (Prentice Hall 1990) pp. 107-108. This embodiment permits the user to adjust parameters for the routing computations, such as speed settings and preferences for/against certain road types as disclosed hereafter. The present technology works, however, with other transport system databases, various types of routes and definitions of routable nodes as well as alternative routing algorithms and adjustable parameters.

Detailed Description Paragraph Right (112):
As shown in FIG. 4, new or recycled routing computations follow input, recall or alteration of a particular waypoint list including a selection of routable nodes which are arranged in an ordinal array according to the user's intended itinerary or order of travel. Provided with input of at least two waypoints, including one point of departure and one destination, step 433 enables the user to select and execute various routing computation options. The system facilitates the following alternative route computations: (1) Quickest, i.e., the route estimated to take the least time to travel between entered waypoints, even if over a longer distance on faster roads (step 437); (2) Shortest, i.e., the route which is the least distance in the actual miles or kilometers, etc. one must travel even if the route takes more time to travel on slow

roads (step 438); and (3) Preferred, i.e., the user can select various road conditions or types to favor or avoid, such as toll roads, forest roads and routes involving car ferries (step 439). The Manage Route dialog box, shown in FIG. 1G, facilitates user choice among the foregoing criteria or variables for routing computations.

Detailed Description Paragraph Right (114):
In FIG. 4, steps 440, 447, 449, 450, 452, and associated paths relate to the menus or dialog boxes which enable users to choose various routing computation options such as Quickest or Preferred routes as illustrated in FIGS. 1H and 1I. Whenever the user elects to alter such routing computation variables, CARPS loops or returns the user to the connector H in FIG. 4 thereafter, giving the user a chance to modify the waypoint list content or not. Then, the user can go to step 433 to implement the altered routing computation. When the user chooses a new routing computation option, for example to avoid one or more types of road in step 443, then step 447 determines whether there is any current route display needing to be cleared away or removed in step 452 before returning the user to H. Steps 449 and 450 administer similar display housekeeping chores in the cases where the user opts to adjust the speed on certain road types in step 441 or to favor selected road types in step 445. In other words, if the user modifies parameters for routing computation in step 440, after any necessary clearing of old displays in 452, the user is returned to step 433 through H for execution of the new form of routing computation, with its new criteria for routing e.g. Quickest instead of Shortest route. The system defaults to computation of the Quickest route through step 433 in the absence of the user picking another parameter. Steps 438 and 439 reflect routing computation options or variables elected by the user through step 440.

Detailed Description Paragraph Right (115):
Other embodiments of the system provide further parameters or options for optimal routing computations. Scenic routes can be identified in the database of highways, roads and other modes of transport such that a minor routine modification of the overall routing algorithm program then enables the user to prefer roads and transport which afford natural vistas and ample opportunities for sightseeing. Similarly, enhancements to the route database can address highway width, clearance and load factors such that the routing algorithm, with minor alterations, can output travel plans suited to the specialized requirements of truckers and heavy transport. Using programming techniques well known in the field of geographic information systems and digital cartography for managing located statistical data expressed in the form of map overlays, routing computations can be integrated with databases relating geographic locations with a broad range of situated conditions. Thus, users of the present invention can choose an optimal route computation which prefers or avoids high crime areas, particular environmental or weather conditions, residential versus industrial or rural as opposed to urban areas, even geocoded demographic or economic factors, provided the embodiment is linked to the appropriate databases.

Detailed Description Paragraph Right (116):
Steps 453, 455, 457, 459 and 461 in FIG. 4 constitute the module for routing output and display including pertinent user options and adjustments. Insofar as no multimedia is combined with routing, step 453 corresponds with step 259 in FIG. 2, i.e., routing output only. But, to the extent that prior multimedia operations and outputs are mixed or combined with a specific routing operation through path 403, steps 465 and 467, then step 453 in FIG. 4 parallels step 265 in FIG. 2. In such cases, step 453 produces output from combined multimedia and routing, mediated by user responses and interaction, involving at least one preceding multimedia operation integrated with at least one ensuing substantial routing operation. For example, a prior multimedia output can get attached to otherwise pure routing output through step 465. Such attached multimedia selections typically include a marginal annotation or digital image with an arrow symbol or graphic pointer indicating a pertinent location on the map display as illustrated in FIG. 1N.

Detailed Description Paragraph Right (118):
Relative to route output/display at 453 in FIG. 4C, CARPS embodiments preferably provide users with some control options or command means (dialog boxes, menus, keystroke sequences, . . . etc.) in order to select various outputs or output combinations. Thus users can select levels of detail, various map printouts and displays, text directions, lists of attachments, supplemental information on POIs,

audio and/or graphics. At 463, users can additionally or alternatively command CARPS electronic/digital output: e.g., (1) uploading waypoints, ordered lists of waypoints, and supplemental information into a compatible GPS--interfacing CARPS--for independent use guiding the user out in the field; or (2) electronic transmission/communication of waypoints, POIs, ordered lists of waypoints and supplemental information to other computers equipped with CARPS for display and processing thereon.

Detailed Description Paragraph Right (119):
As described hereafter in relation to FIGS. 5, 6A and 6B, step 467 in FIG. 4 readjusts the radius or, more generally, the size of the area around intersections or nodes along a computed route within which the travel planning utility looks for POIs as topics for multimedia presentations. This technical process of resetting the geographic area to be searched for multimedia POIs comprises a substantial multimedia operation for combination with routing insofar as readjustment of the radius or POI search area impacts on a map display also exhibiting route output. Resetting the radius or the size of the region searched for POIs impacts on route display/output substantially whenever it causes POIs to be added or deleted from the map display and the related POI list as detailed in relation to FIGS. 5, 6A and 6B.

Detailed Description Paragraph Right (120):
Steps 455, 457, 459, 461, and 463 enable the user to choose among formats for the routing display/output at 453 in FIG. 4. These steps correspond with the more general options for mixed or pure routing output available to the user in steps 215 and 211 in FIG. 2. As shown in FIG. 4, the user options selected through step 455 are controlled through dialog boxes, menus, text commands and other routine user interface technologies. Step 457 enables the user to prompt route output in the form of a voice or text list of waypoints presented in planned order of travel with or without verbal or literal travel directions and other located information associated with items on the waypoint list. Step 457 also allows the user to opt for such audio or text output either in conjunction with or in lieu of the map display or visual route output.

Detailed Description Paragraph Right (121):
For example, while driving, the user of an in-vehicle embodiment can turn off the map display as an unnecessary visual distraction, using step 457 to retain spoken output about waypoints, route directions as well as other located audio information pertaining to places along the way. Step 457 also permits simultaneous audio-visual output, for example, so that the driver can listen to audio output about his or her travel plans while a passenger is also looking at the highlighted route and other information on the map display as illustrated in FIG. 1P. Step 457 further permits turning off the audio output so the driver and passenger can listen to music or converse while the passenger keeps an eye on the visual map/route display. Further details on audio/visual options for multimedia output, which can be combined with routing output at 453, are disclosed in relation to FIGS. 7, 8A-8E.

Detailed Description Paragraph Right (122):
Accessed through step 455 in FIG. 4, step 459 offers user options and controls related to combining multimedia selections with routing output by attaching text, numbers, visual images or sounds or voice. As earlier stated, attaching multimedia refers to processes whereby selected information about locations gets included with map output, but without changing the waypoint input list. For example, the system attaches annotations in the margins of standard strip map travel plan output, as shown in FIG. 1N, with graphic arrows indicating related locations on the background map. A typical text annotation includes the name, address and phone number of a cultural event or attraction: e.g. "Pole-O-Moonshine State Park U.S. Route 9 (518) 834-9045" An arrow stretches from the box containing the text in the margin of the map, pointing out this park's location in Keeseville, N.Y. over on the map portion of the travel plan in FIG. 1N.

Detailed Description Paragraph Right (123):
Such text annotations can attach a broad variety of data and information to map locations including historic facts, environmental data, personal commentary, demographic, economic or political intelligence, news, even ads, jokes, folklore or fictional accounts relevant to the particular location and potentially of interest to the user. By its nature, however, attached information provides supplemental information about places or objects located on or near some pre-existing route

display/output. In the example above, the state park is not made a new waypoint, i.e., it is not treated as a new waypoint input. Rather, the location of the park is pointed out near or along the route display with supplemental information about the park presented in a marginal text annotation. Attach "buttons" are shown for Hotels and Restaurants in the 154 and 156 dialog boxes in FIG. 1L, also for campgrounds in the 158 dialog box in FIG. 1M.

Detailed Description Paragraph Right (124):
The present invention facilitates other forms and methods to attach information about locations. For example, to enhance a hardcopy travel plan for making sales calls on the road, step 459 facilitates attaching digital photos of sales prospects beside marginal notes detailing their name, personal interests and paste purchasing history. This located information aids the user not only to find sales prospects' locations but also to recognize the prospects' faces, remember names and create a more effective and personable impression. Similar attached photographic imagery proves useful with various travel plans: (1) photos of landmarks as navigation aids; (2) digital pictures of drop-off sites, loading docks and other shipping terminal facilities to aid truckers and other delivery personnel; (3) images of industrial facilities, homes, buildings and land as seen from the road to enhance travel plans for real estate surveys, private security, public safety, et.; and (4) attached digital photos enhance scenic or sightseeing travel plans. FIG. 1N illustrates attached digital photos of people and property. Attached images of faces, places or other located content are not limited to still digital photo imagery except in hardcopy output. The system enables attachment of videos, extensive alphanumerical text or voice information about places or POIs, or situated music or natural sounds to map/route displays and electronic output.

Detailed Description Paragraph Right (125):
Along with the marginal note or image box format, attached material car be accessed by clicking the cursor on an appropriate symbol located upon the map/route display. Attached visual and audio material related to the place picked by the user can then be played selectively on the full screen, interrupting the map display for a brief or lengthy time period, at the user's option. In the alternative, the user can attach multimedia selections about locations appearing in windows superimposed upon map/route displays as illustrated at 162 and 165 in FIG. 1-0. These can also be printed out in hardcopy covering portions of the underlying map, as well as in marginal notes or accessible alternative screens.

Detailed Description Paragraph Right (126):
Contrasting with attached multimedia, step 461 in FIG. 4 facilitates combined map/route displays and output whereby the locations or POIs selected by the multimedia user do become new waypoint or routing inputs. In effect, step 461 enables the user to choose a routing display/output format which adds, deletes or inserts POIs selected by the user in multimedia using the module for waypoint input. Instead of just attaching multimedia information about places along a pre-computed route, step 461 causes entry of locations picked by the user in response to multimedia as new waypoint input. Step 461 reformulates the current waypoint list by recycling operations through H. Unless the user chooses otherwise, new waypoints are inserted after or before the closest old waypoint in accord with the user's old order and direction of travel. This new waypoint input in turn prompts a new route computation through step 433 resulting in a corresponding new route output at step 453. Step 461 provides a preferred means for combining routing and multimedia output in cases where the user desires or requires computation/output of a new optimal route based on a new revised waypoint input list including or eliminating locations according to selections by the user made in response to his or her experience of multimedia concerning those locations.

Detailed Description Paragraph Right (128):
Whatever the format and content of a step 453 route output/ display, step 471 enables the user to transfer to the multimedia mode from said routing output/display. Thus, any route output or display can be combined with subsequent multimedia, typically in order for the user to gather more information about an emerging travel plan and the places on his or her itinerary. Consistent with the objective of facilitating flexible sequences and combinations of routing and multimedia operations, the user can eventually return from playing multimedia selections after such a transfer from step 453 through step 471 in order to work on further routing operations, returning via

path 403, step 465 or step 467. Transfers through step 471 entail transformation of routing data into a multimedia format, as detailed in relation to FIGS. 5, 6A and 6B.

Detailed Description Paragraph Right (129):
FIG. 5 illustrates cartographic data structures as seen on typical map/route display output in 501 in the upper left drawing. Underlying cartographic data arrangements, typically not seen by the user are shown at 526 (upper right), 551 (lower left) and 576 (lower right) of FIGS. 5A, 5B, and 5C. They are used in alternative embodiments of the present invention to interrelate nodes or routes with POIs found in one or more user-defined regions around an ordinal series of entered waypoints or along a previously computed route.

Detailed Description Paragraph Right (131):
FIG. 5 comprises one illustration of a map display at 501 as presented on screen to the user in almost all embodiments and typical utilizations of CARPS. 501 is a simplified version of a typical electronic map with a computed route displayed by graphic accentuation, as illustrated in FIG. 1G. While such a map display might not be presented to users in some applications or episodes of use e.g. audio output only embodiments or full screen presentations of graphic images or alphanumeric documents about locations, multimedia and routing functions generally are accomplished by means of the cartographic and geographical information structures illustrated as typically displayed to the user at 501.

Detailed Description Paragraph Right (133):
More specifically, 501 in the upper left of FIG. 5 shows a simplified map display. Such map displays appear on the computer screen serving as a graphic interface in practically all modes of operation and various embodiments of the present invention. The map display in 501 is centered upon a location named PLACE, for purposes of this illustration, situated in between SOUTH PLACE and NORTH PLACE, representing municipalities or parts thereof. As is routine in conventional map making and digital cartography, these entities are represented on maps by their names written on the map with the place name situated on the map in relation to its actual geographic location. Sometimes, place name labels on maps are visually associated with a located symbol, such as a dot or political subdivision boundaries or colored area on the map. No such graphic symbols are associated with the underlined place names in the 501 illustration, however, in the interest of a simpler drawing. Generally, place names comprise a particular cartographic data type. In the underlying geographic information system or database, specific geographic coordinates are linked to each place name. Storage, retrieval, manipulation and linkage of place names are done by means of well known list based, spatial, relational, and other database methodologies which are routinely used for management of geographic point types of data.

Detailed Description Paragraph Right (134):
The present invention further employs such routine database methodologies in order to manage another geographic point type of data namely, the POI or point of interest. POIs appear on the 501 map display as boxed labels e.g. THING at 505. Each POI is placed upon the map display in relation to a certain latitude and longitude, or other set of geographic coordinates, related to a specific location on or near the surface of the earth. CAMP, EAT, POLICE and FUN also comprise POI names or labels upon the 501 map display. In consumer travel planning embodiments of the present invention, POIs typically represent accommodations and recreational attractions. For example, the July 1994 release of MAP'N'GO (TM) by DeLorme Mapping Company, Freeport Me. 04032, included the following predefined types or subtypes of POIs represented on the map display by various colored symbols: (1) Points of Interest, i.e., tourist, recreational and cultural attractions essentially symbolized by red arrows; (2) Hotels also, motels, inns, etc. symbolized by yellow diamonds; (3) Campgrounds symbolized by green triangles; and (4) Restaurants by blue circle symbols. Such symbols indicating the availability of multimedia information on certain types of POIs are illustrated at 157 in FIG. 1M, for example. For purposes of a simplified drawing, in FIG. 5, no such POI symbols appear on the map display shown at 501. On the 501 map display, EAT represents a Restaurant POI; FUN is a particular example of a Point of Interest type of POI; CAMP is a certain Campground POI; and HOTEL exemplifies a Hotel type or subtype of POI.

Detailed Description Paragraph Right (135):
But, POIs are not confined to tourist attractions and travel accommodations.

Alternative embodiments of the present invention handle a great variety of public facilities or infrastructures as geographic point type POI data e.g. POLICE as shown on the 501 map display. Located or locatable objects in geographical space can also qualify as POIs e.g. THING at 505 on the map display shown at 501. THING might comprise a fixed landmark of human or natural origin. THING might also comprise a moveable object such as a vehicle, another item of personal property, a migratory animal or species, a person on foot, or other non-stationary phenomena as currently known, estimated, or predicted to be at a particular location. POIs can also include intended locations such as the proposed location of a building, a place to meet, or the site of a planned event. The term POI or point of interest lower case encompasses extensive types of geographical point data identified with or related to located or locatable objects which can be input, described, depicted and accounted for in a multimedia database.

Detailed Description Paragraph Right (136):
At 510, 512 and 514 in FIG. 5, waypoints comprise a third major type of geographic point data, in addition to place names and POIs. Waypoints is a term utilized in this disclosure for the starting place, ultimate destination and intermediate locations to stop or pass through on an intended trip. Such a waypoint list is a user selection and ordinal arrangement of the routable nodes or geographic point components of the transportation routes or modes of travel subject to routing computations in a given embodiment. To plan automobile travel on national highways and state roads, waypoints are typically defined in terms of road intersections or turning points in line segments or vector data representing routes customarily traveled by ordinary automobiles. For example, waypoints are defined in terms of road intersections and joints between the straight line segments used to represent normal automobile roads and highways in the routing and multimedia software travel planning utility included with the MAP'N'GO (tm) digital atlas of North America on CD-ROM, released by DeLorme Mapping, Freeport Me., 04032 in July 1994. Any place name is linked for purposes of system functions to the nearest node, i.e., road intersection or other juncture between line segments representing roads.

Detailed Description Paragraph Right (137):
For various alternate embodiments, in order to address marine, air flights, off-road, pedestrian or other forms of transport and travel, waypoints are structured according to the physical and mappable characteristics of those other ways of going places. For example, travel by air involves available airports, private planers and commercial lines, safe and customary flight paths, terrain obstacles, etc., which become factors or building blocks for appropriate air waypoint data structures. Travel on foot is also constrained by legal and safety issues exemplified by sidewalks and crosswalks as well as issues of customary paths or trails and natural terrain limitations plus artificial obstacles, etc. Subways, buses and other public ground transportation systems and public or private marine travel also require waypoint data structures appropriate to the mode of transportation, taking into account factors such as available stops, stations, terminals or docks, regular routes, connections and schedules, human or natural obstacles, safe navigation practices, etc. Ordinary CARPS and railroad travel are plainly confined to certain routes and tracks. Travel by air, foot and boat takes place in a more open spatial context still constrained, however, by customary or legal paths or channels and physical obstacles. In the FIG. 5 map display at 501, waypoints 510, 512 and 514 are structured as nodes coinciding with various intersections of ordinary automobile roads and highways.

Detailed Description Paragraph Right (138):
In the 501 map display illustration of FIG. 5, nodes 510, 512 and 514 have been entered in that order as waypoints for a planned trip from SOUTH PLACE, through PLACE to NORTH PLACE. The resulting optimal route computation is being displayed or output by graphical accentuation or highlighting of the recommended route as shown by the fine dotted lines around the optimal route 503 on the 501 map display. This highlighted route is identical with the two-part line segment, representing the route, illustrated at 528, 553 and 578 in the 526, 551 and 576 drawings of FIGS. 5A, 5B, and 5C.

Detailed Description Paragraph Right (139):
The 501 map display illustration further discloses a typical latitude/longitude grid system of horizontal latitude lines e.g. 507 and vertical longitude lines e.g. 508

visibly superimposed as a locational aid over the map display. Such grid systems also are composed in terms of alternate geographic coordinate systems, such as UTM, State Plane as well as proprietary or arbitrary grid systems used for particular map publications. Capital letters on the right side in conjunction with roman numerals that run across the top of the map display form a typical system for identifying or naming individual grids, as a visual user aid for a variety of common map interpretation, cross-referencing and indexing chores. For example, the POLICE POI is found in the C-IV grid.

Detailed Description Paragraph Right (140):
Such grid systems may comprise more than just a visual user aid. The present invention is typically, though not necessarily, implemented in conjunction with a geographic information system, or GIS, which manages spatial data with reference to interrelated matrices of quadrangular grids or tiles constructed substantially parallel to lines of latitude or longitude. Map database systems of this kind are detailed and disclosed, for example, in the David M. DeLorme U.S. Pat. Nos. 4,972,319 and 5,030,117 also, in the now pending U.S. patent application, Ser. No., 08/265,327 David M. DeLorme and Keith Gray inventors, titled COMPUTER AIDED MAP LOCATION SYSTEM.

Detailed Description Paragraph Right (141):
Map database systems or GIS organizing geographic data in terms of tiles, quads, grids or frames present several advantages disclosed in the background art just cited. These advantages generally derive from breaking down the massive amounts of data typically involved in a state of the art GIS into discrete, identifiable, adjacent and related map tiles, quads, grids and frames to store, retrieve, manipulate and integrate geographic information. Rapid generation or redrawing of map displays, recentering or panning across seamless maps, zooming to closer or more outlying map scales, as well as the correlation of located data and the management of cartographic computations are all enhanced by such GIS which manage masses of geographic data in small quadrangular units.

Detailed Description Paragraph Right (142):
Such mapping database systems do not necessarily display the underlying system of map tiles, quads, grids or frames which are used behind the screen by the software. For example, the user can typically turn grid displays or longitude/latitude lines off or on, off to de-clutter the display, or on for better map location and orientation.

Detailed Description Paragraph Right (143):
In FIGS. 5A, 5B, and 5C, the drawings at 526, 551 and 576 illustrate three different cartographic data structures, used behind the screen, for the transformation from routing output or lists of waypoints into POI lists which function as input for subsequent multimedia operations. The 526, 551 and 576 drawings illustrate alternative methodologies, used in conjunction with the present invention, to capture POIs situated within some specified distance along or around previous routing output or waypoints listed in order of intended travel. The preferred embodiments of the system manage transformations from routing to multimedia data structures utilizing GIS or map databases that organize geographic data into tiles, grids, quads or frames. Illustrations 526, 551 and 576 each reveal the same behind the screen or underlying system of grids or tiles for efficient geographic databasing. To simplify these drawings, FIGS 5A, 5B, and 5C show a behind the screen database system of map quads or frames which correspond exactly with longitude/latitude lines and the grid or tile naming system superimposed as a visual aid on the 501 map display of FIG. 5.

Detailed Description Paragraph Right (144):
FIGS. 5A, 5B, and 5C also show POI data corresponding to the 501 map display. For example, the FUN POI in grid C-I upon the 501 map display appears circled as P-F in grid C-I in 526, 551 and 576. Similarly, THING at 505 corresponds to P-T at 536, 559 and 586. Other geographic point data are reproduced exactly from the visible 501 map display over into the underlying behind the screen data representation in 526, 551 and 576. Thus, starting point node 510 in SOUTH PLACE is the same as 534, 557 and 584 in the other three data representations. Elements 512, 530, 555 and 580 all represent the same midjourney waypoint near PLACE. Likewise the end of the trip is shown at 514, 532, 556 and 582. Moreover, the two-part line segment, which is the highlighted route from SOUTH PLACE through PLACE to NORTH PLACE at 503, is reproduced exactly at 528, 553 and 578.

Detailed Description Paragraph Right (155):
As detailed hereafter, further processes explained relative to FIG. 6B loop back through A1. Moreover, in an alternative embodiment, the user can enter A1 at 605 in order to process canned or prepackaged node lists offered as data accessories. A1 at 605 also provides access for the user to recall lists of nodes representative of ordinal waypoint input or routing output from memory or from a database process. Unless processing of a list of nodes for a route between an origin and a destination is complete, step 607 leads to the processing of the next node. After processing of a list of nodes for the route is complete, it passes through 607 and C to the multimedia mode. Steps 608 and 610 get the current node ready for the subsequent search for POIs.

Detailed Description Paragraph Right (164):
At minimum, in the July 1994 release of CARPS, every POI, for which there is information in the database of located multimedia, has one related text message. Typically, such a POI text message literally transcribes the optional audio travelogue narration. Variant embodiments include multiple textual documents linked to individual POIs communicating a broad range of information about the POI location in diverse alphanumerical formats. Examples include comprehensive demographic, historical, or environmental information about locations, commercial or personal data about parties located at residential or business addresses, running inventories or data tabulations pertaining to particular sites, and references to or excerpts from works of fact or fiction citing the location. The first release of the system software does provide detailed text information about rooms, amenities, prices, phone numbers, nearby attractions, etc. for an extensive selection of hotels, campgrounds and other overnight accommodations as illustrated in FIGS. 1L and 1M. As released in July 1994, the system software provides the Show/Tell One multimedia user access to such text displays as an elective option at 714 in FIG. 7. Alternate embodiments default to text output and extend the user options to focus upon specific topics or textual content by means of routine state of the art software text search technologies. Audio and visual images are "played" to accompany or substitute for text in alternate embodiments. CARPS displays such text at the user's option 714 in step 712 in FIG. 7.

Detailed Description Paragraph Right (165):
In FIG. 7, steps 718 and 720 illustrate user options and controls which enhance flexibility and selectivity of play in the multimedia mode. Dotted line boxes and connecting lines, as in 718 and 720 and between 708 and 718, represent user commands, options, and controls made available throughout a series of steps. Thus, for example, step 718 options are available all during any sound 710 or picture 708 show and any text 712 display as well as any combinations thereof. As shown at 748, 749 and 750, the slide control options at step 718 are essentially buttons of the familiar rewind, stop and fast forward types which let the user replay, halt or advance any presentation in any medium. More detail is provided on these slide control options relative to FIG. 8D.

Detailed Description Paragraph Right (166):
CARPS displays pictures or optional text for a preset, adjustable time period. Steps 723 and 727 measure whether this time period has expired and maintain the display of pictures or text until expiration of said time period. Step 720 extends this time period whenever the user elects to call up a dialog box in order to change display settings on the fly or otherwise adjust format or output options for ongoing multimedia. Consistent with overall invention objectives, these features let the user browse or sample multimedia information about a certain location with flexibility to dwell upon or review information of particular interest, or fast-forward through less interesting parts of a presentation. Moreover, a presentation gets extended or prolonged while the user is adjusting the presentation format or proceeding to attach selected POI information to his or her travel plan, or to select or deselect a POI as a waypoint, for purposes of subsequent routing operations. These flexibility features not only enhance the user playing the multimedia in the first instance. Selectivity in the multimedia mode further enables the user to focus upon particular multimedia in order to pick POI locations for transformation into waypoints, or to edit pictorial, text or audio travel information for attachment to travel plans.

Detailed Description Paragraph Right (167):

Steps 729 and 731 remove or end display of pictures or text when the preset time period for display has expired. In the Show/Tell One module, steps 737 and 735 return the user to the POI Listbox, i.e., to connector C in FIG. 3. The user is also returned to the POI Listbox or main multimedia menu at the end of available recorded audio, or if the user employs the 718 slide control in order to stop an ongoing multimedia presentation on a single POI, at step 725. Step 739 presents a modal dialog box routine, in effect, asking the user "Are you done?" whenever a text and picture presentation are complete. At this point, the user can opt to select or delete the pertinent POI or the nearest node as a waypoint or to edit and/or attach multimedia information about the POI to an emerging travel plan. The user hits an OK button in step 741 in order to return through step 743 to step 708 where the picture display clock is restarted. Unless the user opts for a replay of the text option at 714, steps 723, 729 and 735 time out the picture and return the user to the POI list box as shown in FIG. 3 and FIG. 1J at 148.

Detailed Description Paragraph Right (170):
FIG. 7 presumes the underlying map display encompasses or is centered upon the single pertinent POI. But, shown generally at step 307 in FIG. 3 and detailed in FIGS. 8B and 8C the Show/Tell All command prompts multimedia presentations about each item on an entire list of POIs. Depending on map scale and the distance between POIs, not all POIs on a given list necessarily appear on the map display serving as background and cartographic interface on the computer screen for practically all embodiments and usages of the present invention. FIG. 8A illustrates the process that automatically shifts or pans the map display, as required, to center upon the geographic coordinates of the POI currently the focal point of a Show/Tell All multimedia presentation.

Detailed Description Paragraph Right (171):
The processes shown in FIG. 8A commence at connector F as also shown following step 307 in FIG. 3. Step 307 corresponds to step 800 in FIG. 8A. Step 800 presumes a current POI list of two or more POIs. Step 801 initializes the process depicted in FIG. 8A, setting a pointer on the first POI on the current list. This pointer is incremented in various contexts revealed in FIGS. 8B and 8C hereafter. In CARPS embodiment, step 803 in FIG. 8A facilitates Show/Tell All operations looping back up and reentering at F1 for a new cycle of map centering operations each time the Show/Tell All module is ready to focus on the next POI on the current list. Step 803 serves further as entry point for series of multimedia presentations that commence at some user-selected point along a previously computed route or part way down a POI list in alternate embodiments of the present invention.

Detailed Description Paragraph Right (172):
Step 804 fetches the next POI on the current list, i.e., the next POI which is about to become the focus or locus of a multimedia information presentation done in the Show/Tell All module. If the map display is not already centered upon or does not cover this next POI as determined in step 806, then at 808 the map display shifts or pans to recenter approximately on the geographic coordinates of said POI. For example, consider a POI list consisting of two items, namely offices located in Los Angeles and New York City. Assuming that Los Angeles is first on the list, step 808 redraws the map display to center on the New York City office just as the multimedia about the New York office is about to begin and right after multimedia about the Los Angeles site is completed or terminated by the user.

Detailed Description Paragraph Right (173):
Even when the map display easily encompasses successive POIs on a given list, so there is no need to shift or recenter the map display, CARPS indicates the current POI utilizing a characteristic graphic Locator Arrow on screen. Step 810 takes care of drawing such an arrow to the next or newly current POI. Step 810 further removes the Locator Arrow which pointed to the preceding or old POI.

Detailed Description Paragraph Right (176):
From F2, the operations illustrated in FIGS. 8B and 8C proceed to steps 813 and 814 which are implemented concurrently. Although alternate embodiments of the invention might default to a text display of information about the current POI, the Show/Tell All command of the system prefers available sound or audio output and pictures or visual/graphic images. Available sounds, such as travelog narrations, are played at 818 from beginning to end subject to user control of audio volume, tone, etc. in step

825. In alternate embodiments, audio output calls for user interaction or responses. The audio output pauses and waits for an appropriate user response, proceeding apace if the user does not answer for a predetermined interval. CARPS displays available pictures for a preset, adjustable time in step 816.

Detailed Description Paragraph Right (177):
The MAP'N'GO (TM) July 1994 release automatically displays literal nonvocalized text as words printed typically in a window over the map display on screen only in the event that no sound or pictures are available relating to the current POI location. The interplay between steps 813, 814 and 821 demonstrate this logic. However, step 823 enables the user to opt for display of silent alphanumeric text information on screen, supplementing available pictures. This feature addresses the practical reality that, while audio-visual output is preferred for many consumer travel information embodiments, many users and installed systems lack sound cards and speakers. Moreover, though audio output is preferred as a rule for vehicle drivers alone who must keep their eyes on the road and instrument panel, under some circumstances, in vehicle users opt for having a passenger monitor literal text and pictures in windows on the map display, electing to turn the sound off to facilitate conversation or for enjoyment of silence or listening to music tapes or news on the car radio for example.

Detailed Description Paragraph Right (181):
AAA Map'n'Go (TM) 2.0 by DeLorme Publishing Company (assignee of this patent application) includes an embodiment of CARPS including capabilities to interface with GPS receivers such as the Garmin GPS 45 Personal Navigator (TM). This GPS interface facilitates uploading route output or ordered waypoint/node list(s) planned and computed within CARPS into the detachable GPS to guide the user from waypoint to waypoint. During detached use in the field, the GPS unit can also record the specific geographic coordinates of locations or ordered lists of waypoints or nodes visited or passed through by the GPS user at the user's option. Memorized in the GPS unit, such location and/or route data can later be downloaded from the GPS into CARPS for display and other processing or storage in the CARPS database as a record of actual places or paths encountered in the field. The CARPS user could then recall the geographic point(s) recorded by the detached GPS, for example, to retrace the historical route, compare or modify using CARPS and/or communicate the GPS recorded waypoint(s) to another CARPS computer. Coupled with wireless communications means, this CARPS/GPS interface also facilitates downloading of current position and other data into CARPS from detached GPS unit(s) remotely located.

Detailed Description Paragraph Right (184):
While step 818 plays prerecorded audio to its conclusion, steps 816 and 829 work together to display available pictures for a preset, user adjustable period of time. Any text information displays are similarly clocked by means of steps 821 and 835. Unless the user intervenes, located information is heard for its duration, read and seen for a period of time. Once such information plays are over without the user taking action, Show/Tell All proceeds to present multimedia on the next POI. Available at any point in any Show/Tell All output operation, step 819, 866 provides the user with slide controls of the rewind, stop and fast-forward type, revealed in more detail in FIG. 8D. Step 819, 866 lets users discretely replay, extend or advance audio, visual and text outputs together or as individual media. The user can concentrate on, repeat or skip over particular information at will, electing a certain medium or combination of media as well.

Detailed Description Paragraph Right (185):
This capability aids the user to interact with or respond to the multimedia information, for example: (1) to make decisions about which POIs or locations to include or delete as waypoint inputs; or (2) to pick, edit and compose location-related information for attachment to combined travel plan output. Likewise, step 827 stops the clock or blocks expiration of text information outputs or displays whenever the user opts to engage in manipulation or adjustment of the multimedia output/display. This means that the map display and related text information window remain in place focusing on the current POI while the user engages in activities such as resetting the time period for text or visual displays, or resizing or repositioning text or picture windows covering part or all of the map display, or modification of waypoint lists or the attachment of information to travel plans.

Detailed Description Paragraph Right (186):
In FIGS. 8B and 8C steps 831 and 833, 837 and 839, 851 and 853 do essentially the same job for audio, text and visual presentations. These steps increment the POI pointer to the next POI left on the current POI list once a specific presentation is finished or terminated by the user. The user then returns to F1 in FIG. 8A to get the next POI, and recenter the map display if needed.

Detailed Description Paragraph Right (187):
Presentations about the final POI on the current list are complete as determined in steps 831, 853 and 839 respectively for audio, text and pictures. Then the locator arrows for current POIs, see step 810, and other symbols or legends placed on the map display as part of any multimedia presentation, are erased or cleaned up in steps 841, 855 and 846. Then, steps 849, 848 and 863 return the user to the POI Listbox or main multimedia menu, as detailed relative to FIG. 3.

Detailed Description Paragraph Right (188):
In the manner of a modal dialog box, at the end of a text and picture display, step 857 holds text and pictures on screen while asking the user "Are you done?" in effect. The user then can opt to select or delete the pertinent POI or the nearest node as a waypoint, or to edit and attach multimedia information about the POI to an emerging travel plan. Or if the user hits the 859 OK button, then the text display is removed in step 861, and the process returns to restart the picture display clock at step 816. Unless the user opts for a replay of the text option at 823, steps 829 times out the picture. If there still are more POIs on a Show/Tell All list, steps 839 and 837 return the user to connector F1 in FIG. 8A to get the next POI on the current list. At the end of the current POI list, as detected in step 839, step 846 cleans up the map display. At 848, operations are returned to the POI listbox that is detailed further relative to FIG. 3 and FIG. 1J at 148.

Detailed Description Paragraph Right (189):
FIG. 8D details the working of the "stop", "rewind", and "fast-forward" style Slide Control shown at 718 in FIG. 7 and 819 and 866 in FIG. 8. At connector F3, the user is presented on the system interface with optional buttons to replay, halt or advance multimedia presentations. At 874 and 878, the forward and back arrow buttons effectively increment or decrement the POI pointer. Steps 880 and 882 reset the presentation on the beginning of the current list whenever the user backs up past the first item on a given POI list. Thus, full back and forward operations move the user to F2, which is the beginning of Show/Tell operations shown also in FIG. 8B. The Stop button brings multimedia operations to a halt at 872, cleaning up any text or pictures presented in windows on top of the map display in 876. The Stop button takes the user back to the POI listbox which is the startup multimedia mode described in relation to FIG. 3.

CLAIMS:

1. A computer-aided routing and positioning system (CARPS) for use with a device that includes geocoding capability, comprising:

a digital computer having a computer display;

a map database providing a set of electronic maps for presentation on said computer display, wherein said electronic maps have the capability of depicting transportation routes having identifiable waypoints including route intersections at geographical locations along said transportation routes, said identifiable waypoints on said electronic maps being identifiable in said computer by coordinate locations of a selected geographical coordinate system;

a CARPS database of geographically locatable points of interest (POIs) identifiable by coordinate locations in said geographical coordinate system, said POIs being organized into a plurality of types for user selection of POIs by type, said POI types including overlays of said CARPS database for display over said electronic maps on said computer display;

CARPS software permitting user travel planning using said electronic maps presented on

said computer display by providing user selection of selected waypoints that include at least a travel origin and a travel destination and can include intermediate waypoints, wherein said CARPS software is capable of determining an additional group of said intermediate waypoints between said travel origin and said travel destination, and of calculating, delineating, and displaying a travel route between said travel origin and said travel destination via said intermediate waypoints according to user choice of a shortest travel route, quickest travel route, or user-selected preferred travel route;

said CARPS software also permits user selection of a region of interest along said user-defined travel route, said region of interest having user-specified dimensions and permitting user selection of specified POI types within said region of interest and user selection of particular POIs from said selected types within said region of interest, said region of interest being identifiable in said computer by coordinate locations of said geographical coordinate system;

wherein said CARPS database include travel information selected from a group consisting of graphics, photos, videos, animations, audio information, and text information about POIs of said CARPS database and about said transportation routes and said identifiable waypoints of said electronic maps,

wherein said CARPS software is constructed to present a user-customized travelog for preview on said computer display of a user-defined travel route including said travel information in said CARPS database on said selected transportation routes and said selected waypoints of said electronic maps and said selected POIs of said CARPS database in said user-defined region of interest along said travel route, and

wherein said CARPS software permits data transfer between (a) a device that includes geocoding capability and (b) said digital computer.

3. The CARPS of claim 2 wherein said CARPS software is constructed to display a user-customized strip map of said user-defined travel route, wherein said digital computer includes a printer, and wherein said CARPS software is constructed for printing hardcopy maps of said user-customized strip maps to be used in conjunction with said geocoding capable device.

4. The CARPS of claim 2 wherein said CARPS software is constructed so at POI types and particular POIs of said first database selected by said user are displayed as overlays on said electronic maps and said user-customized strip maps.

5. The CARPS of claim 1 wherein said electronic maps, CARPS database, and CARPS software are stored on a CDROM and said digital computer includes a CDROM drive.

6. The CARPS of claim 5 wherein said CARPS software includes a replace function for updating said electronic maps and CARPS database on said CDROM with replacement or supplemental information from another memory device.

7. The CARPS of claim 1 wherein said selected geographical coordinate system is a standard latitude/longitude (lat/long) geographical coordinate system and wherein coordinate locations are stored in said digital computer as lat/long coordinates, and said geocoding-capable device is a global positioning system GPS) receiver.

10. The CARPS of claim 9 wherein said waypoints of said electronic maps comprise information including said transportation routes entering and leaving said respective nodes.

12. The CARPS of claim 1 wherein said geocoding-capable device is a global positioning system (GPS) receiver, and said selected waypoints are user-identified locations that are selectively recorded by a GPS receiver remote from said digital computer and downloaded from said GPS receiver to said CARPS software via a GPS/CARPS interface.

13. The CARPS of claim 1 comprising a set of printed maps substantially coinciding with said set of electronic maps for user cross reference, correlation, and coordination among said computer display presented electronic maps, said geocoding-capable device, and said printed maps.

15. The CARPS of claim 1 wherein said geocoding capable device is a global positioning system (GPS) receiver, said CARPS software permitting said user to download data from said GPS receiver which changes one or more of said travel origin, said travel destination, said transportation routes, and said intermediate waypoints, and said CARPS software recalculates, delineates, and displays on said computer display a revised travel route.

18. The CARPS of claim 1 wherein said digital computer and said geocoding capable device are coupled together, wherein said data transfer is a real-time data transfer of data from said geocoding capable device to said digital computer, and wherein said CARPS software permits tracking and display on said computer display of real-time user locations.

19. A computer-aided routing and positioning system (CARPS) for use with a device that includes geocoding capability, said CARPS comprising:

a digital computer having a computer display;

a map database providing a set of electronic maps for presentation on said computer display, wherein said electronic maps are capable of depicting transportation routes having identifiable waypoints including route intersections at geographical locations along said transportation routes, said identifiable waypoints depictable on said electronic maps being identifiable in said computer by coordinate locations of a selected geographical coordinate system;

a CARPS database of geographically locatable points of interest (POIs) identifiable by coordinate locations in said geographical coordinate system, said POIs being organized into a plurality of types for user selection of POIs by type, said POI types including overlays of said CARPS database for display over said electronic maps on said computer display;

CARPS software permitting user travel planning using said electronic maps presented on said computer display by providing user selection of selected waypoints that include at least a travel origin and a travel destination and can include intermediate waypoints, wherein said CARPS software is capable of determining intermediate waypoints between said travel origin and said travel destination, calculating, delineating, and displaying a user-defined travel route between said travel origin and said travel destination via said intermediate waypoints according to user choice of shortest travel route, quickest travel route, or user-selected preferred travel route;

wherein said user selection of said selected waypoints occurs remote from said digital computer, wherein said selected waypoints are recorded by said user with a device that includes geocoding capability,

wherein said CARPS software permits downloading from said geocoding capable device to said digital computer of data that includes said selected waypoints, wherein said CARPS software permits user selection of a region of interest along said user-defined travel route, said region of interest having user-specified dimensions, and wherein said CARPS software permits user selection of specified POI types within said region and user selection of particular POIs from a selected type within said region of interest, said region of interest being identifiable in said computer by coordinate locations of said geographical coordinate system,

wherein said CARPS database includes travel information selected from a group consisting of graphics, photos, videos, animations, audio information, and text information about POIs of said CARPS database and about waypoints of said electronic maps,

wherein said CARPS software permits uploading from said digital computer to said geocoding-capable device of data that includes said selected waypoints and selected POIs, so as to provide guidance of said user remote from said digital computer,

said CARPS software being constructed to present a user-customized travelog for

preview on said computer display of said user-defined travel route including said travel information in said CARPS database on said waypoints of said electronic maps and said selected POIs of said CARPS database in said user-defined region of interest along said user-defined travel route, said CARPS software also being constructed to display a user-customized strip map of said user-defined travel route along said center of said screen, user-selected POIs in said user-defined region of interest being listed along one side of said strip map with pointers to respective POI locations in said user-defined region of interest, and travel directions along said travel route being listed along said other side of said strip map with pointers to respective intersections corresponding to directions along said user-selected travel route, wherein

said user-customized strip map is vertically oriented with said travel origin at said bottom of said strip map and said travel destination toward said top of said strip map.

20. The CARPS of claim 19 comprising:

a set of printed maps used in conjunction with said geocoding capable device, said printed maps substantially coinciding with said set of electronic maps for user cross-reference, correlation, and coordination between said computer display presented electronic maps and said printed maps and between said computer display presentation of user-defined strip maps and said printed maps and

a grid system of grid lines overlaying said electronic maps and said printed maps, said grid lines defining uniquely named grid quadrangles, said uniquely named grid quadrangles of said electronic maps and printed maps substantially coinciding in geographic areas depicted by said grid quadrangles to facilitate cross reference, correlation and coordination between said computer display map presentations and said corresponding printed maps,

wherein said electronic maps and said printed maps are substantially constant-scale maps.

21. The CARPS of claim 20 comprising electronic maps at a plurality of scales, said maps at each scale being substantially constant-scale maps, said grid system including a plurality of sets of grid lines corresponding to said respective scales and defining uniquely named grid quadrangles at each scale.

25. A computer-aided routing and positioning method (CARPM) using a digital computer with computer display, a map database providing electronic maps having transportation routes, route intersections and identifiable waypoints along said transportation routes for presentation on said computer display, computer aided routing and positioning system (CARPS) software constructed for user travel planning, and a device that includes geocoding capability, said CARPM comprising:

presenting said electronic maps on said computer display;

providing an interface between a device that includes geocoding capability and a digital computer for a transfer of data therebetween;

selecting on said electronic maps at least a user travel origin and a travel destination;

determining intermediate waypoints between said travel origin and said travel destination;

calculating, delineating, and displaying on said computer display a travel route between said travel origin and said travel destination via said intermediate waypoints according to user choice of a shortest travel route, quickest travel route, user-selected preferred travel route, or said transferred data;

selecting a region of interest to said user along said user-defined travel route, said region having user-defined dimensions limiting excursions on either side of said user-defined travel route;

providing a CARPS database of geographically locatable points of interest (POIs) in said geographical areas of said electronic maps, said POIs being organized into a plurality of types for user selection of POI by types, said POI types including overlays of said CARPS database for display over said electronic maps on said computer display, said CARPS database also including travel information selected from a group consisting of graphics, photos, videos, animations, audio information and text information about transportation routes and waypoints of said electronic maps and POIs of said CARPS database;

identifying in said digital computer said transportation routes, route intersections, and waypoints of said electronic maps, region of interest selected by said user, and said selected POIs of said CARPS database, by coordinate locations in a common geographical coordinate system;

selecting specified POI types in said user-defined region of interest along said user-defined travel route and selecting particular POIs from said selected types in said region; and

assembling and displaying on said computer display a user-customized travelog for preview of said user-defined travel route, said travelog including travel information in said CARPS database on said transportation routes and waypoints of said electronic maps and selected POIs in said user-defined region of interest along said user-defined travel route.

26. The CARPM of claim 25 comprising said step of assembling and displaying on said computer display a user-customized strip map of said user-defined travel route.

27. The CARPM of claim 26 comprising said step of displaying said user-customized strip map along said center of said computer display, displaying a list of user-selected POIs in said user-defined region of interest along one side of said user-customized strip map with pointers pointing to respective POI locations in said corridor, and displaying travel directions along said travel route along said other side of said strip map with pointers pointing to respective intersections corresponding to directions along said travel route.

28. The CARPM of claim 27 comprising said step of displaying said user-customized strip map in a vertical orientation with said travel origin at said bottom of said strip map and travel destination toward said top of said strip map.

29. The CARPM of claim 28 comprising said step of printing a hardcopy map of said user-customized strip map showing said user-defined travel route, list of user-selected POIs in said region of interest and respective pointers along one side of said strip map, and said list of directions and respective pointers on said other side of said strip map.

30. The CARPM of claim 25 wherein said electronic maps, CARPS database, and CARPS software are stored on a CDROM and said digital computer includes a CDROM drive and further comprising said step of updating said electronic maps and CARPS database with replacement or supplemental information from another memory device selected from a group consisting of GPS receivers, on-line databases, and PCMCIA RAM cards, using a replace function of said routing software.

31. The CARPM of claim 25 wherein said selected geographical coordinate system is a standard latitude/longitude (lat/long) geographical coordinate system, wherein said geocoding-capable device is a global positioning system (GPS) receiver; and wherein said transferred data is lat/long coordinates.

33. The CARPM of claim 25 comprising said steps of providing a set of printed maps substantially coinciding with said set of electronic maps for user cross reference, correlation, and coordination between said computer display presented electronic maps and said printed maps; and

providing a grid system of grid lines overlaying said electronic maps and said printed maps, said grid lines defining uniquely named grid quadrangles, said uniquely named

grid quadrangles of said electronic maps and printed maps substantially coinciding in geographic areas depicted by said grid quadrangles to facilitate cross reference, correlation and coordination between said computer display map presentations and said corresponding printed maps.

34. The CARPM of claim 33 comprising said steps of providing electronic maps at a plurality of scales, said maps at each scale being substantially constant-scale maps, said grid system comprising a plurality of sets of grid lines corresponding to said respective scales and defining uniquely named grid quadrangles at each scale; and

scrolling across grid quadrangles at said same scale and zooming between quadrangles at different scales, and displaying said scrolling and zooming steps on said computer display.

36. The CARPM of claim 35 comprising said steps of assembling and displaying on said computer display a new user-customized travelog for previewing said new user-defined travel route via said selected POIs.

37. The CARPM of claim 25 comprising said steps of replacing said user-selected intermediate waypoints of incorporating with selectively recorded waypoints recorded by a device that includes geocoding capability, recalculating, delineating, and displaying on said computer display a revised travel route, and assembling and displaying on said computer display a revised user-customized travelog for previewing said revised travel route.

41. A computer aided routing and positioning system (CARPS) for use with a device that includes geocoding capability comprising:

a digital computer having a computer display;

a map database providing a set of electronic maps for presentation on said computer display, said electronic maps depicting transportation routes having identifiable waypoints including route intersections at geographical locations along said transportation routes, said identifiable waypoints depicted on said electronic maps being identifiable in said computer by coordinate locations of a selected geographical coordinate system;

a CARPS database of geographically locatable points of interest (POIs) identifiable by coordinate locations in said geographical coordinate system, said POIs being organized into a plurality of types for user selection of POIs by type, said POI types including overlays of said CARPS database for display over said electronic maps on said computer display;

CARPS software constructed for user travel planning using said electronic maps presented on said computer display, said CARPS software permitting user selection of selected waypoints that include a travel origin, a travel destination, and intermediate waypoints between said travel origin and said travel destination, said CARPS software calculating, delineating, and displaying a travel route between said travel origin and said travel destination via said intermediate waypoints according to user choice of a shortest travel route, quickest travel route, or user-selected preferred travel route, said CARPS software also permitting user selection of a region of interest along said user-defined travel route, said region of interest having user-specified dimensions and permitting user selection of specified POI types within said region of interest and user selection of particular POIs from said selected types within said region of interest, said region of interest being identifiable in said computer by coordinate locations of said geographical coordinate system; and

wherein said CARPS database includes travel information selected from a group consisting of graphics, photos, videos, animations, audio information, and text information about POIs of said CARPS database and about said transportation routes and said identifiable waypoints of said electronic maps,

wherein said CARPS software permits data transfer between (a) a device that includes geocoding capability and (b) said digital computer.

43. The CARPS of claim 41 wherein said digital computer and said geocoding capable device are coupled together, wherein

said data transfer is a real-time data transfer of data from said geocoding capable device to said digital computer, and wherein

said CARPS software permits tracking and display on said computer display of real-time user locations.

46. A computer aided routing and positioning system (CARPS) for use with a global positioning system (GPS) receiver comprising:

a digital computer having a computer display;

a map database providing a set of electronic maps for presentation on said computer display, wherein said electronic maps depicts transportation routes having identifiable waypoints being identifiable in said digital computer by coordinate locations of a selected geographical coordinate system;

a CARPS database of geographically locatable points of interest (POIs) identifiable by coordinate locations in said geographical coordinate system, said POIs being organized into a plurality of types for user selection of POIs by type, said POI types including overlays of said CARPS database for display over said electronic maps on said computer display;

CARPS software permitting user selection of selected waypoints that include at least a travel origin and a travel destination and can include intermediate waypoints, said CARPS software capable of determining intermediate waypoints between said travel origin and said travel destination, and of calculating, delineating, and displaying an optimized travel route between said travel origin and said travel destination via said intermediate waypoints according to user choice of (a) a shortest travel route, (b) a quickest travel route, or (c) a user-selected preferred travel route, said CARPS software also permitting user selection of a region of interest along said user-defined travel route, said region of interest having user-specified dimensions and permitting user selection of specified POI types selected from geographical landmarks within said region of interest and user selection of particular POIs from said selected types within said region of interest, said region of interest being identifiable in said computer by coordinate locations, of said geographical coordinate system, said CARPS software assembling routing data that includes said travel destination, said intermediate waypoints, said POIs, and said travel destination, said CARPS software permitting transfer of said routing data between a GPS device and said digital computer.

47. The CARPS for use with a global positioning system (GPS) receiver as claimed in claim 46 wherein said GPS device is removably coupled to said digital computer.

48. The CARPS for use with a GPS receiver as claimed in claim 47 wherein said routing data is uploaded from said digital computer to said GPS device and provides remote guidance to a user of said GPS device independent of said digital computer.

49. The CARPS for use with a GPS receiver as claimed in claim 47 wherein said routing data is uploaded from said digital computer to said GPS device and provides user guidance,

said GPS device determining real-time data that includes real-time user location coordinates and downloading said real-time data to said digital computer,

said CARPS software permitting a reiteratively updated display of said real-time data on said computer display in the form of indicators overlayed on said optimized travel route.

50. A program storage device readable by a machine, tangibly embodying a program of instruction executable by said machine to perform in association with a device that includes geocoding capability method steps for computer-aided routing, said method steps comprising:

recording a first series of waypoints on a GPS receiver;

presenting electronic maps on a computer display;

downloading said first series of waypoints from said GPS receiver to a computer aided routing and positioning system (CARPS);

converting said first series of waypoints field to a user travel origin, intermediate waypoints, and a travel destination;

calculating, delineating, and displaying on said computer display a travel route between said user travel origin and travel destination via said intermediate waypoints according to user choice of a shortest travel route, a quickest travel route, or a user-selected preferred travel route;

selecting a region of interest to said user along route of said user-chosen travel route, said region having user-defined dimensions limiting excursions on either side of said user-defined travel route;

providing a CARPS database of geographically locatable points of interest (POIs) in said geographical areas of said electronic maps, said POIs being organized into a plurality of type for user selection of POIs by type, said POI types including overlays of said CARPS database for display over said electronic maps on said computer display, said CARPS database also including travel information selected from a group consisting of graphics, photos, videos, animations, audio information and text information about transportation routes and waypoints of said electronic maps and POIs of said CARPS database;

identifying in said digital computer said transportation routes, route intersections, and waypoints of said electronic maps, region of interest selected by said user, and said selected POIs of said CARPS database, by coordinate locations in a common geographical coordinate system;

selecting specified POI types in said user-defined region of interest along said user-defined travel route and selecting particular POIs from said selected types in said region;

assembling and displaying on said computer display a user-customized travelog for preview of said user-defined travel route, said travelog including travel information in said CARPS database on said transportation routes and waypoints of said electronic maps and selected POIs in said user-defined region of interest along said user-defined travel route;

converting said user-defined travel route to a second series of waypoints;

uploading said second series of waypoints to said GPS receiver for remote guidance of said user along said user-defined travel route.

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L11: Entry 32 of 86 File: USPT Jan 2, 2001

DOCUMENT-IDENTIFIER: US 6169515 B1
TITLE: Navigation information system

Abstract Paragraph Left (1):
A navigation information system includes a communications system having a fixed part and at least one mobile part, the fixed part including data storage and a processor identifying the location of a mobile unit, generating guidance information appropriate to that location and transmitting it to the mobile unit. By locating most of the complexity with the service provider, in particular the navigation computer and geographical database, the system can be readily updated and the capital cost of the in-vehicle system, which in its simplest form may be a standard cellular telephone, can be minimized. The user makes a request for guidance information, and the system, having determined the user's present location, then transmits instructions to the user. The user's present location can be determined by a Satellite Positioning System or the like.

Brief Summary Paragraph Right (2):
This invention relates to navigation information systems. It is particularly suitable for use in providing users of road vehicles with route guidance, but other applications are possible and are discussed below.

Brief Summary Paragraph Right (4):
Navigation of a vehicle through an unfamiliar complex road network is a difficult task. Large amounts of fuel and time are wasted as a result of drivers getting lost or using an inefficient route. Accidents can also be caused by drivers attempting to read maps or complex road signs and losing concentration on the road ahead. Moreover, a driver may choose an inefficient route as a result of using an out-of-date map.

Brief Summary Paragraph Right (5):
An additional problem can occur even if a driver knows a route to his or her destination. That route may be congested or blocked as a result of accidents or maintenance work, so that an alternative route would be more efficient.

Brief Summary Paragraph Right (6):
Several proposals have been made for navigation guidance systems. In some such proposals a vehicle-borne system has a navigation computer and a geographical information system which is essentially a digitised map stored on a CD-ROM. The system gives the driver information and guidance by screen and/or speech display. These systems would be very expensive. Each vehicle requires a navigation computer and geographical information system. The cost of the complex vehicle-borne equipment involved is estimated to be in the region of .English Pound.1000. The system is complex to operate, and could only be safely operated by the driver whilst the vehicle is stationary. The geographical information system would require periodic updating, which requires new disks to be distributed to subscribers from time to time.

Brief Summary Paragraph Right (9):
In an alternative approach a system of short-range roadside beacons is used to transmit guidance information to passing vehicles equipped with simple transceivers. The beacons transmit information to suitably equipped passing vehicles to give turn instructions appropriate to their chosen destinations. For each beacon the territory to be covered is divided into as many zones as there are exits from the junction the beacon relates to. The zone in which the user's chosen destination falls is

determined, and instructions are given appropriate to that zone. At any given beacon all vehicles whose destinations are in the same zone get the same instruction. The definitions of the zones are dependant on the location of the beacons, and each zone comprises the set of destinations which should be reached from the beacon by taking the direction associated with that zone.

Brief Summary Paragraph Right (10):
Each beacon only gives instructions for reaching the next beacon along the route to the vehicle's destination. For two vehicles starting from the same point for different destinations for which the routes are initially coincident, the beacons along the coincident section of route will each give both users the same instructions, because for those beacons both users are travelling to the same zone. Only for the beacon at the point of divergence are the two users' destinations in different zones, and therefore different instructions are given.

Brief Summary Paragraph Right (11):
The beacons programming may be modified from time to time by control signals from a central control station, in a way analogous to remotely controlled adjustable signposts, but in its interactions with the user equipment the beacon is autonomous, identifying which of its zones the user's desired destination is in, and transmitting the appropriate "turn" information to get it to the next beacon on the way. The beacon has no knowledge of the rest of the route.

Brief Summary Paragraph Right (12):
Each beacon has a detailed map of a small local area (the boundaries of which are, in fact, the adjacent beacons), and if the destination is in this area the beacon gives full information of the route to the destination. The system can therefore provide a user with directions to a destination defined more precisely than the beacon spacing. However, at the beginning of a journey, a user cannot use the system until he encounters a beacon.

Brief Summary Paragraph Right (15):
According to a first aspect of the invention, there is provided a navigation information system for providing information to a mobile user dependent on the location of the mobile user, the system comprising a mobile communications system having a fixed part and one or more mobile units for communicating with the fixed part, each mobile unit including means for transmitting to the fixed part a request for guidance information relating to a destination specified by the user of the mobile unit, and for receiving such guidance information from the fixed part, and the fixed part including: means for determining the location of a mobile unit requesting guidance information, means for generating guidance information according to the present location and specified destination of the mobile unit, and means for transmitting the guidance information so generated to the mobile unit, whereby information dependent on the present location and specified destination of the mobile unit can be transmitted to the mobile unit.

Brief Summary Paragraph Right (16):
According to a second aspect of the invention, there is provided a navigation information system for providing information to one or more mobile users dependent on their locations, the system comprising: means for determining the location of a mobile unit requesting guidance information relating to a specified destination, means for generating information for guidance of the user of the mobile unit according to the present location and specified destination of the mobile unit, and a communications system for transmitting the guidance information so generated to the mobile unit, whereby guidance information dependent on the present location and specified destination of the mobile unit can be transmitted to the mobile unit.

Brief Summary Paragraph Right (17):
According to a third aspect, there is provided a mobile unit for a navigation information system, comprising means for identifying the present position of the mobile unit, means for transmitting, over a communications link, a request for guidance to a specified destination, and guidance instruction means controllable by guidance instruction information received over the communications link, whereby guidance instructions between the present location and the specified location can be communicated to a user by means of the guidance instruction means.

Brief Summary Paragraph Right (18):
According to a fourth aspect, there is provided a method of providing navigation guidance information to mobile units of a mobile radio system, the information being dependent on the locations of the mobile units, the method comprising the steps of: transmitting, from a mobile unit to the fixed part, a request for navigation guidance to a specified destination; determining the location of the mobile unit; generating guidance information on the basis of the location information, the requested destination, and navigation data stored in the fixed part; and transmitting the guidance information from the fixed part to the mobile unit; whereby guidance information relevant to the present location and specified destination of the mobile unit is transmitted to the mobile unit.

Brief Summary Paragraph Right (19):
This invention has advantages over both the prior art systems discussed above. Considerable improvements can be made over the prior on-board navigation system proposals by putting the intelligence in the fixed part of the system. Firstly, there is no need to distribute maps or updates to subscribers because the data is held centrally. New roads can be added to the system at the instant they are opened. Total capital expenditure is minimised since all users share the same database. Moreover, the computing resources are used more efficiently, because an in-vehicle system spends most of its time inactive but a centralised system can the time-shared.

Brief Summary Paragraph Right (21):
Preferably the system includes means for determining the location of the mobile part in relation to a geographical overlay comprising a plurality of overlay areas, and means for transmitting information associated with an overlay area which includes the location of the mobile part, whereby a mobile part within that overlay area receives information associated with that overlay area. This allows information associated with a particular overlay area to be transmitted to any mobile units in that overlay area. The system may also comprise means for determining when a mobile part enters a predetermined overlay area, and means for transmitting a message, to a user other than the said mobile part, in response to the said mobile part entering the predetermined overlay area. For example, one overlay area may cover part of a road approaching a junction, and the message may be the appropriate instruction to the driver, as he approaches the junction, as to which way he should turn. Each individual overlay area therefore gives navigation instructions specific to that overlay area. The overlay areas may overlap, and may be of any size down to the practical minimum of the resolution of the location determination process. Large overlay areas are suitable for transmitting general information, whilst smaller areas can be used to target information to users in very precise locations, such as individual elements of a complicated road layout. The overlay areas may be delimited in two or three dimensions.

Brief Summary Paragraph Right (24):
The fixed part may include means for storing map information or other data for use in providing information, herein referred to as guidance data, means for updating the stored guidance data, means for identifying mobile parts to which the updated data are applicable, and means for transmitting such data over the communications system to the mobile parts so identified. This allows information about changing traffic situations to be transmitted to all users who will be affected, without needing to broadcast the details to other users as would be the case with those prior art systems where updating is possible.

Brief Summary Paragraph Right (27):
The data stored in the data storage means may be updated, for example in response to changing traffic conditions, accidents, or highway maintenance. The system may include means for identifying the mobile units to which the updated data are applicable, and transmitting amended instructions over the communications system to said mobile parts. With knowledge of the journeys being planned by a large number of users, a better prediction of demand for particular roads (and hence of congestion on those roads) can be built up. This can be more stable than existing autonomous route-planning systems because the navigation system can take account of the journeys planned for other users.

Brief Summary Paragraph Right (29):
The means for determining the location of the mobile part may comprise means to interrogate a location-identifying means forming part of the mobile part operating for example by means of dead reckoning from a known start point, using an inertial navigation system or distance and direction measuring devices such as a compass and an odometer. Alternatively, the means for locating position may include means for identifying the location of the mobile part in relation to elements of the fixed part of the communications system. The location of the mobile part may be determined by a radio location system associated with the cellular radio system. In another alternative arrangement, a satellite navigation system may be used. In one preferred arrangement the fixed part has means to determine the approximate location of the mobile part, and the location identifying means of the mobile part is arranged to respond to a location request from the interrogation means with a non-unique location signal which, in combination with the approximate location determined by the fixed part, determines a unique location.

Brief Summary Paragraph Right (30):
In a preferred arrangement, the fixed part and the mobile parts each have a satellite navigation system receiver, and the positions of the mobile parts as measured by the satellite navigation system are compared with those of the fixed part as measured by the satellite navigation system. The position of the fixed part can be known with great accuracy and provides a reference measurement which allows the position of the mobile part to be determined with greater accuracy than is possible by direct measurement using the satellite system alone.

Brief Summary Paragraph Right (33):
For some applications the vehicle may be controlled directly in response to the guidance information received over the communications link. However, for use on the public highway, it is preferable that the guidance information controls display means, which may be visual or audible or both, to indicate to a driver the direction to take.

Drawing Description Paragraph Right (2):
FIG. 1 shows a mobile part and a fixed part of a navigation information system according to an embodiment of the invention;

Detailed Description Paragraph Right (1):
According to the embodiment of FIG. 1 the navigation system has a fixed part (comprising elements 12 to 19) and a number of mobile parts, of which one only is shown (comprising elements 1 to 10), interconnected by a cellular telephone network 11.

Detailed Description Paragraph Right (2):
The mobile part comprises a mobile telephone 1 having an audio output 2, an audio input 3 and a radio antenna (transmit/receive) 4. The output 2 is connected to a decoder 5 to translate Dual-Tone Multi-Frequency (DTMF) signals received by the telephone 1 into data which is fed to an interface controller 6. The interface controller 6 also receives input from a GPS (Global Positioning System) satellite receiver 7. The interface controller transmits data to a DTMF encoder 8 which generates tones to be fed to the audio input of the mobile telephone. The audio output 2 and input 3 also include a loudspeaker 9 and microphone 10 respectively, to allow the telephone to be used for speech.

Detailed Description Paragraph Right (4):
The mobile part obtains location information using the GPS receiver 7 and transmits this information, together with a request for directions to a specified destination, to the fixed part, where a server 16 relates the location information to its geographical database 17 and obtains message information associated with the location from the database 18, and transmits the information back to the mobile part.

Detailed Description Paragraph Right (9):
At the start of a journey the driver requests service by activating a pre-dialled control on the telephone 1. This service request is transmitted to the control interface 14 over the telephone network 11. The control interface 14 then allocates a free server 16 to answer the call and interrogate the vehicle GPS receiver 7 to

determine its geographical position. The encoder 8 takes the latitude and longitude data and translates the numbers into DTMF tone-pairs, in a manner to be described in more detail below.

Detailed Description Paragraph Right (12):
The server 16 then captures the current position of the user, and identifies the overlay area within which that position falls. The server also captures any permanent user-specific information such as the type of vehicle, which may be relevant for the route to be selected e.g. because of height or weight restrictions. The user may encode those requirements which are not permanent, but are specific to the present information request, (in particular his destination) by using the telephone keypad in response to voice prompts. However, in a preferred arrangement the call is presented to a human operator for the capture of this data. This allows the user to obtain assistance in identifying his desired destination to the system, and also allows the driver to speak his requirements, keeping his hands and eyes free for driving.

Detailed Description Paragraph Right (13):
The operator then remotely programs the in-vehicle interface 6 with system data identifying the vehicle destination, for use in subsequent update processes, and instigates the generation of voice given directions and instructions to the driver by a speech generation subsystem of the computer server 16.

Detailed Description Paragraph Right (18):
Using the data collected by this method, it is possible for the central system to derive a digital map of valid routes. The following data could be derived automatically: valid travel lanes; permitted directions) of flow; allowable turns; average travel times; trends in travel times according to time of day and other factors.

Detailed Description Paragraph Right (19):
The system would automatically update the map to show permanent changes (new road links, changes to one way systems etc.). Temporary lane closures from road works etc. would also be recorded. Manual updating of data would be necessary (for instance to alert the system to a new bypass opening) before the system acquired the information from vehicle flow data, to ensure vehicles are routed over the new road initially. Any approximations in the pre-entered data would automatically be corrected by the system described here.

Detailed Description Paragraph Right (21):
The variation of transit time trends according to time of day, for each link, could be used to derive a congestion prediction model, as the basis for route guidance. The system may monitor the progress of the mobile units along the routes selected for them, to identify any areas of traffic congestion etc, by comparing actual transit times between predetermined locations. This may be done by the fixed system monitoring the location updates of individual units, or it may be done by the mobile unit, in co-operation with the fixed unit. In this latter case, the fixed part transmits an expected range of transit times within which the mobile is expected to reach a predetermined location. If the mobile unit reaches the location outside this range, it reports the fact to the fixed part. By "reporting by exception" the data processing overhead can be reduced considerably.

Detailed Description Paragraph Right (24):
If the central system detected a problem (from vehicle data or other sources), which had a severe impact on predictions, sufficient to cause a change to advice already given, then the central system could broadcast news of the problem, such that those vehicles affected could automatically call in via a mobile data communications link to receive a new route from its present location to its destination.

Detailed Description Paragraph Right (26):
The data flowing though the system will therefore allow it to "learn" more of the road network's characteristic congestion behaviour, e.g. by use of neural net techniques, and to select routes for traffic which avoid using routes at times when they are likely to be congested. In addition, the system can generate digital road maps or other data automatically, based on the position measurements of vehicles using the roads.

Detailed Description Paragraph Right (27):
A particular advantage of this system is the ability to predict unusual patterns of congestion from the route guidance information requested by the users. Because route guidance is generated centrally, the system can monitor the number of requests for destination information to a given location. By determining the predicted arrival times for each user (which will depend on their starting points, and the time the journey started), a build-up of traffic converging on a particular location at a particular future time (e.g. for a major sporting event) can be detected. Traffic for other destinations, which might have been routed by way of this location, can then be diverted to other routes.

Detailed Description Paragraph Right (31):
The location-determination system will now be described in greater detail. GPS (Global Positioning System) satellite navigation receivers are now becoming very cheap and are available with a serial data output. These can provide latitude and longitude data to within a tenth of a second of arc (defining position to within 3 meters, which is sufficient to identify which carriageway of a dual carriageway road a user is on),

Detailed Description Paragraph Right (32):
Satellite positioning systems such as the Global Positioning System (GPS) are prone to small systematic errors, for example as a result of instabilities in the orbits of the satellites. The accuracy of the position measurement may be enhanced by a process known as "Differential GPS" in which a number of fixed reference points are used, whose positions are determined with great precision e.g. using surveying techniques. GPS is used to obtain a measure of the position of one or more of the fixed reference points. This measure is compared with the known, true location to generate a correction value which can be used to correct the position of the mobile unit as measured by GPS.

Detailed Description Paragraph Right (34):
For larger territories e.g. a pan-European system, or one covering the USA, this simple method of data reduction is impractical. However, it is nevertheless possible to reduce the data requirements by dynamically defining the territory. After an initialisation step using the full location, the system selects as each new location the closest candidate to the previous one. For example, if the mobile unit was last reported at 99 degrees W and the units digit of the longitude is now 0, the user is taken to be at 100 degrees W rather than, for example, 90 degrees or 110 degrees.

Detailed Description Paragraph Right (35):
If location updates take place sufficiently frequently that the user's position cannot have changed by more than half a degree, the units digit of degrees may also be dispensed with, and the location given only in minutes and seconds of arc. The more frequent the updates, the more digits can be dispensed with.

Detailed Description Paragraph Right (37):
By left-truncating the position data by omitting the degrees digits a basic position message would therefore consist of 10 decimal digits (minutes, seconds, and tenths of seconds). Altitude data giving altitude in meters would require a further four digits, since all points on the Earth's surface lie within a range of 10,000 meters, but this data can also be left-truncated, as it is unlikely that any multi-level road system would exceed 100 meters in height (or if it did, that a GPS system would work effectively for any receiver on the lower levels). This gives a total of twelve digits, which can be transmitted by DTMF in less than 2 seconds.

Detailed Description Paragraph Right (40):
If the mobile unit fell within the same overlay area at the previous location update, and the message associated with that overlay area is unchanged, the transmission of the message may be suspended.

Detailed Description Paragraph Right (41):
The frequency at which location updates are requested by the system may be tailored to the size and nature of the current overlay area. For example, an intricate road layout may comprise a large number of small overlay areas, requiring frequent location updates to ensure that a user does not miss an instruction by passing through its

associated area between two updates. However, a long stretch of road without junctions may be covered by a single overlay area, so less frequent updates are appropriate. The speed with which a vehicle is likely to be moving, which will differ between urban, rural, and motorway environments may also be used as a factor in determining when the next location update should be requested.

Detailed Description Paragraph Right (42):
As suggested above, there may be circumstances when a satellite positioning system may be unusable, for example in tunnels or built-up areas where a line-of-sight view of the satellites may be impossible to obtain. Alternative arrangements for identifying and updating the mobile part's location which do not rely on a satellite receiver may be used, either on their own, or to interpolate between points where a satellite system can be used. In one variant, a navigation system based on dead-reckoning may be used. In such systems the user identifies his initial location and the on-board system measures the system's movement e.g. by magnetic bearing measurements, distance counters, and inertial navigation means such as gyrocompasses and accelerometers. Such systems are self-contained, but require knowledge of the starting point. This may be obtained, for example from a satellite positioning system.

Detailed Description Paragraph Right (44):
Examples of the kind of navigation information which may be stored in the database 17 will now be discussed, with reference to FIGS. 2 to 6. Briefly, FIG. 2 shows a junction J having four approach roads 21, 22, 23, 24; each having associated with it an overlay area 21a, 22a, 23a, 24a respectively. In this figure, and all other figures illustrating road layouts, the roads are shown arranged for lefthand running, as used for example in the UK, Japan, Australia etc. FIG. 3 shows part of a road network surrounding the junction J, including towns A, B, C, and a motorway M. Each of the roads 21, 22, 23, 24 has an associated destination zone 21z etc. FIG. 4 shows a complex grade-separated junction interlinking four roads N, S, E, W. The junction has superimposed on it an overlay having twelve overlay areas, Na, Ni, Nd, Sa, Si, Sd, Ea, Ei, Ed, Wa, Wi, Wd. FIG. 5a shows a small region having a main road 33 and a side road 30. The main road 33 has two associated overlay areas 31, 32. FIG. 5b is similar to FIG. 5a, but an obstruction X is present on the main road 33, and the overlay area 32 has been subdivided into two overlay areas 32a, 32b, separated by the obstruction. FIG. 6 shows an overlay comprising ten overlay areas 40-49 superimposed on a cellular radio coverage region comprising five cells 50-54.

Detailed Description Paragraph Right (45):
In greater detail, the road junction J (FIG. 2) has four approach roads 21, 22, 23, 24. On each road, at the approach to the junction, an overlay area (21a, 22a, 23a, 24a) is defined. These overlay areas have directional information associated with them, giving turn instructions or other navigational information. As shown in FIG. 3, the entire territory covered by the navigation system can be divided into four zones 21z, 22z, 23z, 24z, each comprising the set of all locations for which the corresponding road 21, 22, 23, 24 should be taken from the junction J. In this particular example, road 24 leads directly into town A and is only used for local destinations (zone 24z), road 23 leads to town B (zone 23z), road 22 leads to town D (zone 22z) and road 21 leads to the motorway M, for all other destinations including town C and part of town A. These zones are defined differently for each junction: for example at junction J' different directions are appropriate for towns A and C, so these towns fall in different zones with respect to the overlay areas at that junction. The zones may even be defined differently for different overlay areas at the same junction. For example, if U-turns are not possible at the junction J, any traffic approaching the junction J by road 22 and requiring town D (perhaps as the result of a previous error, or a change of plan) must be routed by way of roads 21, M, and 25. Thus, for overlay area 22a there are only three zones: 24z, 23z and the combined 21z/22z, corresponding to the three permitted exits 21, 23, 24.

Detailed Description Paragraph Right (47):
The overlay areas 21a, 22a, 23a, and 24a should be large enough to ensure that any vehicle approaching the junction gets at least one location update whilst within the relevant overlay area, and is thus sent the relevant turn instruction. As shown in FIG. 2, these overlay areas are discrete, and may be considered equivalent to the coverage areas of the beacons of the prior art system discussed above. They may, however, be made contiguous, as shown in FIGS. 4, 5a, 5b and 6.

Detailed Description Paragraph Right (48):
FIG. 4 shows a more complex, grade-separated junction, in which there are twelve overlay areas Each road N, E, S, W intersecting at the junction has a corresponding approach overlay area Na, Ea, Sa, Wa, (Wa shown shaded), and a depart overlay area Nd, Ed, Sd, Wd (Ed shown shaded). There are also four intermediate overlay areas Ni, Ei, Si, Wi (Si shown shaded). In the vicinity of the flyover F height (altitude) information obtainable from the GPS system can be used to determine which level, and therefore which overlay area, the user is currently in.

Detailed Description Paragraph Right (49):
The approach and intermediate overlay areas each end at a decision point P1 to P8. In the database 17 each overlay area has direction information associated with it, providing instructions as to which fork to take at the associated decision point. For example, the direction information associated with zone Si instructs users for destinations served by road N to go straight on at point P1, and users for destinations served by roads E, S, and W to turn left. It will be seen that traffic using the intersection will pass through one approach overlay area, one departure overlay area, and may also pass through one or more intermediate overlay areas. There may also be information associated with the departure overlay areas Nd, Sd, Ed, Wd, for example warning of hazards ahead. The departure overlay areas may be continuous with approach overlay areas for the next junction in each direction.

Detailed Description Paragraph Right (50):
As a user approaches the junction on road S, a location update identifies the user equipment as being within overlay area Sa. If the co-ordinates of the user's destination are within the zone served by road W, the user is sent an instruction to turn left at point P2. If the user obeys this instruction, he will enter overlay area Wd and on the next location update he will be sent information relevant to that overlay area (if any).

Detailed Description Paragraph Right (51):
If the co-ordinates of the user's destination are within the zone served by road N, the user in overlay area Sa is instead sent an instruction to continue straight on at point P2. If the user obeys this instruction, he will enter overlay area Si.

Detailed Description Paragraph Right (52):
For a user in overlay area Si, if the co-ordinates of the user's destination are within the zone served by road N the user is sent an instruction to go straight on at point P1. On obeying this instruction, he will enter the overlay area Nd and on the next location update he will be sent information relevant to that overlay area (if any).

Detailed Description Paragraph Right (53):
If the co-ordinates of the destination of a user in overlay area Si are in the zone served by roads E, S, or W, the user will be sent an instruction to turn left at point P1. On obeying this instruction, he will enter overlay area Wi.

Detailed Description Paragraph Right (54):
Similar information is associated with the other overlay areas. By being given appropriate instructions as the user negotiates a succession of junctions (decision points), the user can be directed to any destination. It should be noted that all users who are to be directed to the same exit from the junction are given the same instruction, whatever their ultimate destination.

Detailed Description Paragraph Right (56):
In FIG. 5b the major road 33 has been blocked at a point X. In order to accommodate this, the overlay area 32 has been subdivided into two overlay areas 32a, 32b. The information (if any) associated with overlay area 32b is the same as that previously associated with overlay area 32. Traffic in overlay area 32a is given new information warning it of the hazard ahead. The information associated with the overlay area 31 is modified, so that all traffic is now instructed to turn off onto the side road 30. (Effectively this means that the destination zones associated with the overlay area 31 are merged into one)

CLAIMS:

1. A navigation information system for providing information to a mobile user dependent on the location of the mobile user, the system comprising:

a mobile communications system having a fixed part and a plurality of mobile parts for communicating with the fixed part,

each mobile part including means for transmitting to the fixed part of a request for guidance information relating to a destination specified by the user of the mobile part, and for receiving such guidance information from the fixed part, and

the fixed part including:

means for determining the location of a mobile a requesting guidance information,

means for generating guidance information according to the present location and specified destination of the mobile part, and

means for transmitting the guidance information so generated to the mobile part,

whereby information dependent on the location and specified destination of the mobile part is transmitted to the mobile part,

means for determining the location of the mobile part in relation to a geographical overlay comprising a plurality of discrete predetermined overlay areas, and

means for transmitting guidance information associated with an overlay area which includes the location of at least one mobile part,

whereby mobile parts within that overlay area simultaneously receive the same guidance information associated with that overlay area.

7. A navigation information system for providing information to a mobile user dependent on the location of the mobile user, the system comprising:

a mobile communications system having a fixed part and a plurality of mobile parts for communicating with the fixed part,

each mobile part including means for transmitting to the fixed part a request for guidance information relating to a destination specified by the user of the mobile part and for receiving such guidance information from the fixed part, and

the fixed part including:

means for determining the location of a mobile part requesting guidance information,

means for generating guidance information according to the present location and specified destination of the mobile part, and

means for transmitting the guidance information so generated to the mobile part,

whereby information dependent on the location and specified destination of the mobile part is transmitted to the mobile part,

means for determining the location of the mobile part in relation to a geographical overlay comprising a plurality of discrete predetermined overlay areas, and

means for transmitting guidance information associated with an overlay area which includes the location of at least one mobile part,

whereby mobile parts within that overlay area simultaneously receive the same guidance information associated with that overlay area,

means for locating the position of the mobile part by radio location,

wherein the means for locating position comprises:

a satellite navigation system receiver, and

means for identifying the location of the mobile part in relation to elements of the fixed part of the communications system.

8. A navigation information system for providing information to a mobile user dependent on the location of the mobile user, the system comprising:

a mobile communications system having a fixed part and a plurality of mobile parts for communicating with the fixed part,

each mobile part including means for transmitting to the fixed part a request for guidance information relating to a destination specified by the user of the mobile part and for receiving such guidance information from the fixed part, and

the fixed part including:

means for determining the location of a mobile part requesting guidance information,

means for generating guidance information according to the present location and specified destination of the mobile part, and

means for transmitting the guidance information so generated to the mobile part,

whereby information dependent on the location and specified destination of the mobile part is transmitted to the mobile part,

means for determining the location of the mobile part in relation to a geographical overlay comprising a plurality of discrete predetermined overlay areas, and

means for transmitting guidance information associated with an overlay area which includes the location of at least one mobile part,

whereby mobile parts within that overlay area simultaneously receive the same guidance information associated with that overlay area, and

means for locating the position of the mobile part by radio location and comprising at least one of:

(a) a satellite navigation system receiver, and

(b) means for identifying the location of the mobile part in relation to elements of the fixed part of the communications system.

11. A navigation information system

for providing information to a mobile user dependent on the location of the mobile user, the system comprising:

a mobile communications system having a fixed part and a plurality of mobile parts for communicating with the fixed part,

each mobile part including means for transmitting to the fixed part a request for guidance information relating to a destination specified by the user of the mobile part and for receiving such guidance information from the fixed part, and

the fixed part including:

means for determining the location of a mobile part requesting guidance information,

means for generating guidance information according to the present location and specified destination of the mobile part, and

means for transmitting the guidance information so generated to the mobile part,

whereby information dependent on the location and specified destination of the mobile part is transmitted to the mobile part,

means for determining the location of the mobile part in relation to a geographical overlay comprising a plurality of discrete predetermined overlay areas, and

means for transmitting guidance information associated with an overlay area which includes the location of at least one mobile part,

whereby mobile parts within that overlay area simultaneously receive the same guidance information associated with that overlay area,

wherein the mobile part has means for location its position by dead reckoning.

12. A navigation information system

for providing information to a mobile user dependent on the location of the mobile user, the system comprising:

a mobile communications system having a fixed part and a plurality of mobile parts for communicating with the fixed part,

each mobile part including means for transmitting to the fixed part a request for guidance information relating to a destination specified by the user of the mobile part and for receiving such guidance information from the fixed part, and

the fixed part including:

means for determining the location of a mobile part requesting guidance information,

means for generating guidance information according to the present location and specified destination of the mobile part, and

means for transmitting the guidance information so generated to the mobile part,

whereby information dependent on the location and specified destination of the mobile part is transmitted to the mobile part,

means for determining the location of the mobile part in relation to a geographical overlay comprising a plurality of discrete predetermined overlay areas, and

means for transmitting guidance information associated with an overlay area which includes the location of at least one mobile part,

whereby mobile parts within that overlay area simultaneously receive the same guidance information associated with that overlay area,

wherein the fixed part includes means for generating and maintaining guidance data based on vehicle movement data derived from time information and position measurements of a plurality of the mobile parts and estimations of future locations of the mobile parts based on the guidance information previously transmitted to the mobile parts.

17. A navigation information system for providing information to a mobile user dependent on the location of the mobile user, the system comprising:

a mobile communications system having a fixed part and a plurality of mobile parts for communicating with the fixed part,

each mobile part including means for transmitting to the fixed part a request for guidance information relating to a destination specified by the user of the mobile part and for receiving such guidance information from the fixed part, and

the fixed part including:

means for determining the location of a mobile part requesting guidance information,

means for generating guidance information according to the present location and specified destination of the mobile part, and

means for transmitting the guidance information so generated to the mobile part,

whereby information dependent on the location and specified destination of the mobile part is transmitted to the mobile part,

means for determining the location of the mobile part in relation to a geographical overlay comprising a plurality of discrete predetermined overlay areas, and

means for transmitting guidance information associated with an overlay area which includes the location of at lest one mobile part,

whereby mobile parts within that overlay area simultaneously receive the same guidance information associated with that overlay area,

wherein the fixed part includes means for generating and maintaining guidance data based on at least one of:

(a) vehicle movement data derived from time information and position measurements of a plurality of the mobile parts, and

(b) estimations of future locations of the mobile parts based on the guidance information previously transmitted to the mobile parts.

19. A navigation information system for providing information to each of plural mobile users dependent on their locations, the system comprising:

means for determining the location of a mobile part requesting guidance information relating to a specified destination,

means for generating information for guidance of the user of a mobile part according to the present location and specified destination of the mobile part, and

a communications system for transmitting the guidance information so generated to the mobile part,

whereby guidance information dependent on the present location and specified destination of the mobile part is transmitted to the mobile part,

means for determining the location of a mobile part in relation to a geographical overlay comprising a plurality of discrete predetermined overlay areas, and

means for transmitting guidance information associated with an overlay area which includes the location of at least one mobile part,

whereby mobile parts within that overlay area simultaneously receive the same guidance information associated with that overlay area.

32. A mobile unit for a navigation information system, said mobile unit comprising:

means for identifying the present position of the mobile unit,

means for transmitting, over a communications link, a request for guidance to a specified destination, and

guidance instruction means controllable by guidance instruction information received over the communications link and associated with one of a plurality of discrete predetermined geographical overlay areas containing said present position,

whereby guidance instructions between the present location and the specified location are communicated to a user by means of the guidance instruction means.

35. A method of providing navigation guidance information to mobile parts of a mobile radio system, the information being dependent on the locations of the mobile parts, the method comprising the steps of:

transmitting, from a mobile part to the fixed part, a request for navigation guidance to a specified destination,

determining the location of the mobile part;

generating guidance information on the basis of the location information, the requested destination, and navigation data stored in the fixed part; and

transmitting the guidance information from the fixed part to the mobile part;

whereby guidance information relevant to the present location and specified destination of the mobile part is transmitted to the mobile part;

determining the location of the mobile part in relation to a geographical overlay comprising a plurality of discrete predetermined overlay areas,

generating guidance information associated with an overlay area which includes the location of at least one mobile part, and

transmitting guidance information associated with the relevant overlay area to mobile parts within that overlay area,

whereby mobile parts within that overlay area simultaneously receive the same guidance information associated with that overlay area.

41. A method of providing navigation guidance information to mobile parts of a mobile radio system, the information being dependent on the locations of the mobile parts, the method comprising:

transmitting, from a mobile part to the fixed part, a request for navigation guidance to a specified destination,

determining the location of the mobile part;

generating guidance information on the basis of the location information, the requested destination, and navigation data stored in the fixed part; and

transmitting the guidance information from the fixed part to the mobile part;

whereby guidance information relevant to the present location and specified destination of the mobile part is transmitted to the mobile part;

determining the location of the mobile part in relation to a geographical overlay comprising a plurality of discrete predetermined overlay areas,

generating guidance information associated with an overlay area which includes the location of at least one mobile part, and

transmitting guidance information associated with the relevant overlay area to mobile parts within that overlay area,

whereby mobile parts within that overlay area simultaneously receive the same guidance information associated with that overlay area,

wherein the position of the mobile part is identified by a radio location method, and

wherein the position of the mobile part is determined by means of a satellite navigation system and by identifying the location of the mobile part in relation to

elements of the fixed part of the communications system.

42. A method as in claim 40, wherein the position of the mobile unit is determined by at least one of:

(a) use of a satellite navigation system and

(b) by identifying the location of the mobile part in relation to elements of the fixed part of the communications system.

45. A method of providing navigation guidance information to mobile parts of a mobile radio system, the information being dependent on the locations of the mobile parts, the method comprising:

transmitting, from a mobile part to the fixed part, a request for navigation guidance to a specified destination,

determining the location of the mobile part;

generating guidance information on the basis of the location information, the requested destination, and navigation data stored in the fixed part; and

transmitting the guidance information from the fixed part to the mobile part;

whereby guidance information relevant to the present location and specified destination of the mobile part is transmitted to the mobile part;

determining the location of the mobile part in relation to a geographical overlay comprising a plurality of discrete predetermined overlay areas,

generating guidance information associated with an overlay area which includes the location of at least one mobile part, and

transmitting guidance information associated with the relevant overlay area to mobile parts within that overlay area,

whereby mobile parts within that overlay area simultaneously receive the same guidance information associated with that overlay area,

wherein the mobile part identifies its position by dead reckoning.

46. A method of providing navigation guidance information to mobile parts of a mobile radio system, the information being dependent on the locations of the mobile parts, the method comprising:

transmitting, from a mobile part to the fixed part, a request for navigation guidance to a specified destination,

determining the location of the mobile part,

generating guidance information on the basis of the location information, the requested destination, and navigation data stored in the fixed part, and

transmitting the guidance information from the fixed part to the mobile part;

whereby guidance information relevant to the present location and specified destination of the mobile part is transmitted to the mobile part;

determining the location of the mobile part in relation to a geographical overlay comprising a plurality of discrete predetermined overlay areas,

generating guidance information associated with an overlay area which includes the location of at least one mobile part, and

transmitting guidance information associated with the relevant overlay area to mobile

parts within that overlay area,

whereby mobile parts within that overlay area simultaneously receive the same guidance information associated with that overlay area,

generating and maintaining data based on vehicle movement data derived from time information and position measurements of a plurality of the mobile parts and estimations of future locations of the mobile parts based on the guidance information previously transmitted to the mobile parts.

50. A method of providing navigation guidance information to mobile parts of a mobile radio system, the information being dependent on the locations of the mobile parts, the method comprising:

transmitting, from a mobile part to the fixed part, a request for navigation guidance to a specified destination,

determining the location of the mobile part;

generating guidance information on the basis of the location information, the requested destination, and navigation data stored in the fixed part; and

transmitting the guidance information from the fixed part to the mobile part;

whereby guidance information relevant to the present location and specified destination of the mobile part is transmitted to the mobile part;

determining the location of the mobile part in relation to a geographical overlay comprising a plurality of discrete predetermined overlay areas,

generating guidance information associated with an overlay area which includes the location of at least one mobile part, and

transmitting guidance information associated with the relevant overlay area to mobile parts within that overlay area,

whereby mobile parts within that overlay area simultaneously receive the same guidance information associated with that overlay area, and

including at least one of:

(a) generating and maintaining data based on vehicle movement data derived from time information and position measurements of a plurality of the mobile parts and

(b) estimations of future locations of the mobile parts based on the guidance information previously transmitted to the mobile parts.

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Abstract Paragraph Left (1):
A vehicular navigation system includes: a current position detection unit for detecting the current position of the vehicle; an information storage unit for storing map information for conducting route searching and for providing route guidance; an input unit for inputting a destination and inputting instructions for executing a search of the map information for a route from the current position detected by the current position detection unit to the destination; an output unit for outputting information for route guidance; and a central processing unit for temporarily memorizing a route detected by the route search and for outputting a signal to the output unit to provide route guidance according to the memorized route. The central processing unit judges whether or not one information storage unit has been replaced by another and, when replaced, if the destination has not been reached, conducts another route search from the current position to the destination.

Brief Summary Paragraph Right (2):
The present invention relates to a navigation system which conducts route searching and route guidance to a predetermined destination.

Brief Summary Paragraph Right (4):
Various vehicle navigation systems which conduct route guidance to a destination from a point of departure or current position through passing points, with display and voice guidance, have been proposed. The typical vehicle navigation system stores guidance data in its information storage unit, inclusive of map data, data for features of crossings and passing points and display and voice data, searches the map data to determine an optimum route from the current or departure location to the destination (route search), and provides route guidance. Thus, the typical vehicle navigation system includes an input/output device for inputting and outputting information related to route guidance, a current position detection unit for detecting information relating to the current position of the vehicle, an information storage unit for storing navigation data necessary for determination of a route and display/voice guidance data or the like necessary for route guidance, and a central processing unit for conducting route search processing, display guidance processing necessary for route guidance, and control for the overall system.

Brief Summary Paragraph Right (5):
Generally, the information storage unit, as shown in FIG. 13, includes indexed files of map data, search data, guidance data, map matching data, destination data and the like, i.e. provides a database storing all data necessary for the navigation system. As an actual storage medium, a CD-ROM is often used for this purpose. The stored navigation programs will include both OS (operating system) and application programs. The application programs include a map drawing program, route search programs, route guidance programs, current position calculation programs, and destination setting operation control programs. The map drawing program, the route search program, the route guidance program, the current position calculation program, and the destination setting operation control program are executed utilizing map data, search data, guidance data, map matching data and destination data, respectively. Because the current position calculation program can calculate a current position using map data, by using the same map data for the map drawing program and for the current position calculation program, omitting duplication of map data, it is possible to reduce the

total amount of data.

Brief Summary Paragraph Right (6):
The present position calculation section detects current location position by comparing direction information and distance information obtained from signals of the relative direction sensor, the absolute direction sensor and the distance sensor with map data or map matching data. Responsive to input of the destination or to an instruction to execute a route search, the route search program is executed to search for an optimum route using map data. When guidance is started, the route guidance section displays a map indicating direction of travel relative to the current location, outputs remaining distance to an intersection, identifies a feature or point being passed, travel direction at an intersection, information pertaining to the identified feature or point, utilizing guidance data associated with the determined route, by visual display and voice.

Brief Summary Paragraph Right (7):
The conventional vehicle navigation systems are generally classified as one of two types. In one type, as shown in FIG. 14(b), only data is stored in a CD-ROM, while application and OS programs are stored in a ROM of the central processing unit. In a second type, shown in FIG. 14(a), a program and data are stored in a CD-ROM and a program memory area consisting of a RAM or a flash memory is provided in the central processing unit to read a program each time it is required.

Brief Summary Paragraph Right (8):
The navigation map storage media may include a map for the entire country (nation-wide map) stored in a single storage medium, local map storage media for each local area, with the entire country covered by a plurality of such local map storage media and sightseeing map storage media in which additional information such as tour guidance is added for a particular area. To provide these different map media with compatibility so they can be processed in the same apparatus, data format is usually standardized. However, any of the following circumstances may be encountered:

Brief Summary Paragraph Right (10):
(2) Although the format of the stored data is the same, map information such as position coordinates, name and shape is different; or

Brief Summary Paragraph Right (12):
However, because as mentioned above, the data media include a nation-wide version, local versions and genre-based versions (for sightseeing, leisure, and the like), and because some local versions represent different geographic divisions, and a given program is provided with a plurality of data CD-ROMs, if the CD-ROM is changed, destination and search conditions (express road priority or the like) must be reset and an instruction for execution of route search must be input, which operations required of the user have proven inconvenient. Even in the case of identically formatted local versions, if they are developed separately, even if they use the same coordinates, information as to road numbers, intersection and exit numbers and search conditions may be different. Additionally, because a guidance route is usually memorized in the form of road numbers and intersection/interchange/exit numbers, if the CD-ROM is replaced after the guidance route has been determined by route search and memorized, the route search function becomes disabled.

Brief Summary Paragraph Right (13):
Further, with regard to the above-classified three different sets of circumstances, in case (1), a new disk replacing the former disk cannot be activated. In case (2), although the disk can be activated because its data format is the same, because the data content is different it is impossible to provide guidance for a route determined before the new disk was read. In case (3), although it seems that route guidance before the disk is replaced is possible because the data style and content are based on the same standard, because the data content is different, it is impossible to provide complete compatibility. For example, a road which exists in a local version may not exit in a nation-wide version. Thus, to receive appropriate route guidance, each time a disk is replaced, it is necessary to again set a destination, to again set a search condition and to repeat the process of route determination from the beginning, at an inconvenience to the user.

Brief Summary Paragraph Right (14):
In conventional navigation systems, by changing the CD-ROM between various CD-ROMs for different geographic areas, purpose or genre, such as for sightseeing, golf, and the like, it is possible to achieve smoother and more comfortable guidance. Thus, a plurality of the CD-ROMs are typically stored in a single case so that the CD-ROM from which information is to be read, at the command of a user, can be changed manually.

Brief Summary Paragraph Right (15):
However, in a conventional navigation system in manually changing the CD-ROMs from which information is to be read, among a plurality of stored CD-ROMs, no attention is paid to the information content of the CD-ROMs. For example, in using a navigation system in which five CD-ROMs are stored, a CD-ROM in the first position of the changer is moved to an optical head and by the next command for change, the second CD-ROM is moved to the optical head. In this manner, only a mechanical change is performed.

Brief Summary Paragraph Right (16):
In other words, the conventional navigation system does not automatically take into account the information stored in the CD-ROMs when changing CD-ROMs. Thus, by a manual change command through a switch input, a new CD-ROM is set on the optical head and information of this CD-ROM is read and its contents are displayed on the display screen. Then, the user can judge whether or not the new CD-ROM is that desired. Therefore, if the replaced CD-ROM is not that desired, the user must again input a CD-ROM change command to the navigation system, a very troublesome procedure.

Brief Summary Paragraph Right (17):
Thus, in the prior art system, in changing CD-ROMs, the new CD-ROM to be selected cannot be identified with certainty and the desired CD-ROM cannot be selected rapidly. Because a sightseeing CD-ROM, a leisure CD-ROM, a golf CD-ROM and/or a detailed road map information storage CD-ROM for the same area are all present in the changer, even if the road map information recorded on the CD-ROMs is the same, the user may become confused as to which CD-ROM should be selected and must confirm the contents of all the CD-ROMs.

Brief Summary Paragraph Right (18):
In addition, the changing of CD-ROMs is accompanied by two large time lags, the time required to mechanically move the new CD-ROM to the optical head and the time required to read information from the CD-ROM and to display it on the display screen. Thus, in a navigation system employing a plurality of CD-ROMs which may be loaded, selecting a CD-ROM appropriate for the current location and type of destination is very difficult for the user.

Brief Summary Paragraph Right (19):
In a navigation system in which only a single CD-ROM can be loaded, the user has to replace the CD-ROM manually. Thus, if the vehicle moves from the geographical range of one local version CD-ROM across to the geographical range of another local version CD-ROM, the user must replace the CD-ROM while the vehicle is moving. Such replacement of the CD-ROM is not easy during movement of the vehicle. In addition, when the CD-ROM is replaced, a route re-search must be conducted based on road information contained in the new (replacement) CD-ROM. Thus, the navigation guidance is stopped for a specific time just after the replacement.

Brief Summary Paragraph Right (21):
Thus, the present invention provides a navigation system for conducting route search to determine an optimum route to a designated destination and for providing route guidance. The navigation system of the present invention includes: a current location detection unit for detecting the current (present) location of the vehicle; a removable information storage unit (external) for storing map and other route information for conducting route search and for providing route guidance; an input unit for inputting a destination and inputting an instruction to execute a route search of the stored map information in one information storage unit to determine an optimum (guidance) route from the current location detected by the aforementioned current location detection unit to the input (designated) destination; an output unit for outputting information for route guidance; and a central processing unit for temporarily memorizing the route determined by the route search and for outputting a signal to the output unit to provide route guidance according to the memorized route.

The central processing unit judges whether or not the information storage unit has been replaced and, in response to detection of the replacement of the one information storage unit by another, retains in memory at least a portion of the data associated with previously determined guidance route if the destination has not yet been reached and conducts a route search from the current position to the destination based on the retained data and the map data contained in the new information storage unit.

Brief Summary Paragraph Right (22):
According to another aspect of the present invention, there is provided a navigation system in which the information storage unit stores programs for conducting the route search and route guidance and the central processing unit includes an internal storage means for storing the programs which, if the program of a new (replacement) information storage unit is different from that of the information storage unit which it is replaces, stores the former program in internal storage means. The central processing unit memorizes a search condition and a guidance route and if a guidance route to a destination has not been terminated is stored when the aforementioned information storage unit is replaced, conducts a route search from the current position to the destination based on the aforementioned search condition.

Brief Summary Paragraph Right (23):
According to the present invention, replacement of a CD-ROM is detected, and if a guidance route in which a guidance up to its destination has not been completed is memorized, route search is conducted from the current position to the destination responsive to detection of replacement of one CD-ROM with another. Therefore, once instructions for route search and route guidance have been issued by inputting the location of the destination, it is not necessary to re-enter the destination or the like or to instruct a new route search each time the CD-ROM is replaced in order to receive route guidance to the destination. Further, replacement of the CD-ROM is detected, in the case when a program stored in the CD-ROM is written into an internal RAM or flash memory for startup, it is possible to also utilize a program on the new CD-ROM by writing the program into memory.

Brief Summary Paragraph Right (24):
A further object of the present invention is to provide a navigation system in which a plurality of CD-ROMs are loaded and which is capable of automatically and rapidly selecting a CD-ROM for use in navigation. Therefore, in another embodiment the present invention provides a navigation system comprising a plurality of external information storage units, e.g. CD-ROMs, each a different degree of specificity with regard to map information, and wherein an external information storage unit in current use may be replaced by an external information storage unit means having more detailed map information pertaining to the current location of the vehicle. Thus, in this latter embodiment, the present invention provides a vehicle navigation system including: current location detecting means for detecting the current location of the vehicle; a plurality of external information storage media for storing map information; management means for managing the external information storage media; control means for selecting at least one of the information storage media corresponding to the current location of the vehicle by comparing information in the plurality of the information storage media managed by the management means with information for the current location of the vehicle; and means for changing to another selected external information storage medium.

Brief Summary Paragraph Right (25):
According to a further aspect, the present invention provides a vehicle navigation system including: current location detecting means for detecting the current location of a vehicle; a plurality of removable information storage media for storing map information; management means for managing the removable information storage media; control means for selecting one of the removable information storage media corresponding to the current location of the vehicle by comparing information in the plurality of the removable information storage media managed by the management means with information for the current location of the vehicle; a first map information storage means for memorizing route information corresponding to the current location of the vehicle on the basis of map information stored in the first removable information storage medium; means for changing from an external information storage medium, other than the first removable information storage medium selected by said control means, to a second removable information storage medium corresponding to the

current location of the vehicle; a second map information storage means for memorizing route information corresponding to the current location of the vehicle on the basis of map information stored in said second removable information storage medium; changeover means for changing map information responsive to a changeover request; and output means for changing from the first map information storage means to the second map information storage means when a changeover request is dispatched from said changeover means and outputting route information of the second map information storage means.

Brief Summary Paragraph Right (26):
A map information storage means, in which the coordinates of the detected current location of the vehicle are included in the geographical coordinate range of its stored map information, is selected from the plurality of the map information storage means and then map information is read out from that selected storage means and displayed. Further, map information storage means in which the category (field), purpose or genre of an input destination is included in its stored map information may be selected from the plurality of map information storage means and its map information read out and displayed.

Brief Summary Paragraph Right (27):
As described above, in the navigation system mounted on a vehicle according to the present invention, a CD-ROM which is appropriate for the current location of the vehicle is selectable so that it is possible to provide guidance information properly, in response to a request from a user.

Brief Summary Paragraph Right (28):
Further, by judging that, during travel of a vehicle with guidance of a nation-wide version CD-ROM, the vehicle is approaching the map area of a local version CD-ROM, and by preliminarily reading information of the local version CD-ROM and memorizing route information up to a destination in a storage means, responsive to such a judgement, for example, RAM or the like, when a user requests to change to a detailed local version CD-ROM, it is possible to immediately change over to the required map information thereby providing timely information and improving operation efficiency.

Brief Summary Paragraph Right (29):
Still further, it is possible to provide guidance in accordance with a specific interest of the user, e.g. a ski guide CD-ROM, sightseeing CD-ROM or the like, as well as map disks and to accurately select a CD-ROM suitable for the current location and destination of the vehicle.

Drawing Description Paragraph Right (1):
FIG. 1 is a block diagram showing an entire embodiment of a vehicle navigation system according to the present invention.

Drawing Description Paragraph Right (5):
FIG. 5 is a flow chart of the main routine for operation of the navigation system in accordance with the present invention.

Drawing Description Paragraph Right (13):
FIG. 13 is a diagram illustrating arrangement of application programs and data utilized for navigation.

Drawing Description Paragraph Right (14):
FIGS. 14a and 14b are diagrams illustrating correspondence between storage information on a CD-ROM utilized in a conventional vehicle navigation system and its central processing unit (ECU).

Drawing Description Paragraph Right (15):
FIG. 15 is a block diagram of a vehicle navigation system according to an embodiment of the present invention.

Drawing Description Paragraph Right (16):
FIG. 16 is a flow chart (1) of a program loading routine utilized in an embodiment of the vehicle navigation system of the present invention.

Drawing Description Paragraph Right (18):

FIG. 18 is a flow chart of a program loading routine utilized in an embodiment of a vehicle navigation system according to the present invention.

Drawing Description Paragraph Right (20):
FIG. 20 is a flow chart of a routine for changeover to a residential map according to an embodiment of the present invention.

Drawing Description Paragraph Right (21):
FIG. 21 is a flow chart of a routine for a residential map display according to an embodiment of the present invention.

Drawing Description Paragraph Right (22):
FIG. 22 is a diagram showing a display changeover screen (No. 1), for changing to a residential map etc., according to an embodiment of the present invention.

Drawing Description Paragraph Right (23):
FIG. 23 is a diagram showing another display changeover screen (No. 2), for changing to a residential map etc., according to an embodiment of the present invention.

Drawing Description Paragraph Right (25):
FIG. 25 is a diagram showing an example of the representation of road map data at the lowest reduced scale.

Drawing Description Paragraph Right (26):
FIG. 26 is a diagram showing an example of representation of residential map data stored in the CD-ROM 37.

Drawing Description Paragraph Right (29):
FIG. 29 is a flow chart of a main routine for operation of the entire navigation system.

Detailed Description Paragraph Right (2):
FIG. 1 shows an embodiment of a the navigation system according to the present invention including an input/output unit 1 for inputting and outputting information for route guidance, a current location detecting unit 2 for detecting information concerning the current location of the vehicle, an information storage unit 3 for storing navigation data necessary for determining a route, visual/audio guidance data necessary for guidance along the determined route and programs (application and/or OS), and a central processing unit 4 for controlling the entire system.

Detailed Description Paragraph Right (4):
The input/output unit 1 has a function for instructing the central processing unit 4 to provide navigation processing at a driver's disposal such that the guidance information can be output audibly and/or through a display screen when the driver so requests, with additional output of processed data through a printer. As a means for achieving that function, the input section includes a touch switch 11 or operation switches for entering a destination by telephone number or coordinates on a map and for requesting route guidance. Of course, a remote controller may be used as an input device instead. The output section of unit 1 includes a display 12 for automatically displaying route guidance on the screen in response to a driver's request, a printer 13 for printing data processed in the central processing unit 4 and/or data stored in the information storage unit 3, and speakers for outputting the route guidance audibly.

Detailed Description Paragraph Right (5):
A voice recognition device which enables voice input or a recording card reading device for reading data written in an IC card or a magnetic card may be added to the system. It is also possible to add a data communication device for data exchange with a remote information source such as an information center which stores data necessary for navigation and supplies such data through a communication line in response to a driver's request or with an electronic notebook in which data customized for the driver, such as map data and destination data, is stored.

Detailed Description Paragraph Right (6):
Display 12 is a color CRT or a color liquid crystal display and outputs all screens

necessary for navigation, such as a route setting screen, based on map data and guidance data processed by the central processing unit 4, an interval map screen and an intersection map screen in color, and further displays buttons (switches) in the screen for setting route guidance and for switching guidance or screens providing route guidance.

Detailed Description Paragraph Right (7):
This display 12 is mounted in an instrument panel in the vicinity of the driver's seat. The driver recognizes the current location of his vehicle by watching the interval map and obtains information for the route which he will follow. The display 12 is provided with touch switches 11 corresponding to the indications of the function buttons. Touching the touch switch 11 executes the above-mentioned operation based on a corresponding signal input. The input signal generation means, comprising this button and the touch switches, constitutes the input section.

Detailed Description Paragraph Right (8):
The current location detecting unit 2 comprises a GPS receiver unit 21 utilizing a global positioning system (GPS), a beacon receiver unit 22, a data sending/receiving unit 23 for receiving a GPS compensation signal using, for example, a cellular phone or FM multiplex signal, an absolute direction sensor 24 in the form of, for example, a geomagnetic sensor, a relative direction sensor 25 in the form of a wheel sensor, a steering sensor, a gyroscope or the like, and a distance sensor 26 for detecting travel distance according to the number of revolutions of a wheel.

Detailed Description Paragraph Right (9):
The information storage unit 3 stores a program and data for navigation. The program comprises a map drawing section, route search section, route guidance section, a current position calculation section, a destination setting operation control section and the like, and includes application programs for signal output processing for navigation, operating system programs and the like. A program for route searching, programs for display output control necessary for route guidance and audio output, data necessary therefor and display information data necessary for route guidance and map display are stored therein. The stored data includes files of map data, search data, guidance data, map matching data, destination data and the like and all data necessary for operation of the navigation system.

Detailed Description Paragraph Right (10):
The central processing unit 4 comprises a CPU 40 for executing various arithmetic operations, a flash memory which is a second RAM 41 for reading a program from a CD-ROM loaded into the information storage unit 3 and storing it, a ROM 42 for storing a program in the flash memory 41, a RAM 43 for temporarily storing route guidance information such as a location coordinates of a set destination, road name code No. and the like and data currently used in an arithmetic operation, picture memory 44 for storing picture data for use in the display, a picture processor 45 for retrieving picture data from the picture memory 44 on the basis of a display output control signal from the CPU 40, processing the data and outputting it to the display, a voice processor 46 for synthesizing voice, phrases, complete sentences, sounds and the like from data read out from the information storage unit 3, on the basis of an audio output control signal from the CPU, by conversion of the read data into analog signals for output to a speaker 16, a communication interface 47 for handling input and output data in communication with a remote station, a sensor input interface 48 for receiving a sensor signal from the current location detecting unit 2, and a clock 49 for entering date and time into internal diagnostic information. In this embodiment route guidance is provided in the form of screen display and, optionally, voice output if selected by the driver.

Detailed Description Paragraph Right (12):
A road number is specified for each road section between junctions and for each direction (outbound and inbound). The road attribute data is road guidance subsidiary information data, which provides information about elevated and underground roads, e.g. as to whether a road is elevated, beside an elevated road, an underground road, or beside an underground road, and information as to the number of lanes. When the shape data is divided by a plurality of nodes for each road as shown in FIG. 2(B), the respective node number m has coordinate data for its east longitude and north latitude. The guidance data comprises intersection (or access/exit point) names,

caution point data, road name data, road name audio data address and size and destination data address and size, as shown in FIG. 2(c).

Detailed Description Paragraph Right (13):
Caution point data includes information as to whether or not the caution point is a railroad crossing, tunnel entrance, tunnel exit, or road narrowing (lane merge) point and data for providing a caution message to a driver for a railroad crossing, a tunnel or the like, other than a junction or intersection, as shown in FIG. 4(A). The road name data is, as shown in FIG. 3(B), data providing information about road type such as express road, urban highway, toll road, general road (national road, prefectural road, other) and data showing a trunk line or feeder road for an express highway, urban highway and/or toll road, comprising road type data and road type internal number which identifies each road type. The destination data, as shown in FIG. 2(D), comprises destination road number, destination name, and destination name audio data address and size, destination direction data and travel guidance data.

Detailed Description Paragraph Right (14):
The destination direction data, as shown in FIG. 2(E), is data for information for, invalid (no destination direction data is used), unnecessary (not guided), straight travel, to the right, obliquely to the right, back to the right, to the left, obliquely to the left and back to the left. The travel guidance data, as shown in FIG. 4(B), indicates which lane a vehicle should travel if there are a plurality of lanes and this data translates into information as to right lane, left lane, center lane or none.

Detailed Description Paragraph Right (15):
The overall operation of the above-described navigation system is executed according to the steps shown in FIG. 5. First, a current location (point of departure) necessary for route search is obtained by the current location detecting unit (step S11). Next, a destination is set according to a destination input from the input device through the destination setting screen (step S12), and a route search is executed and then a guidance route thereby determined is memorized in a route storage means (step S13). If a guidance start instruction is input, route guidance control means starts route guidance, detects the current location of the vehicle through the current location detection unit and traces the current location (step S14). On the basis of a guidance route memorized in the route storage means, guidance information is output to an output device in the form of voice and/or visual display to provide route guidance (step S15). Then, by comparing the current location with a destination, arrival at the destination is judged (step S16), and if it is judged that the destination has been reached, the route guidance is terminated. According to the present invention, to cope with a replacement of a CD-ROM (information storage unit), a route search routine is executed at the time of disk replacement as shown in FIG. 6, by periodic interruption.

Detailed Description Paragraph Right (16):
In the route search routine executed at the time of disk replacement, first, disk management information is read from a CD-ROM (step S21) and whether or not a CD-ROM has been replaced is determined from disk management information read at this time, as compared with previously memorized disk management information (retained data) (step S22). If it is judged that the CD-ROM has been replaced, the read disk management information is memorized and updated (step S23). Then, whether or not a guidance route has been memorized is determined (step S24) and if a guidance route has been memorized, that guidance route is deleted (step S25). Whether or not a destination has been already been reached is investigated (step S26) and if the destination has not been reached, a route search for a route from the current location to the destination is executed (step S27). If it is judged that the CD-ROM has been not replaced, if it is judged that no guidance route has been memorized, or if it is judged that the destination has been reached, this interruption processing is terminated.

Detailed Description Paragraph Right (18):
With the disk changer type reading unit, by storing a plurality of different disks in the unit, such as a nation-wide version, a local version and a sightseeing version, users can easily choose a disk which suits their purpose. For example, in long-distance traveling, a plurality of disks are sometimes needed to reach a destination from a current position. In this case, it is preferable to first receive

route guidance by calculating a route using a nation-wide version disk and then to replace it with a local version disk or a sightseeing version disk having more information, when the vehicle approaches the destination.

Detailed Description Paragraph Right (20):
The central processing unit reads disk information from the disk when it recognizes that the disk has been changed, and compares and judges its format, sentence meaning, version and the like with those of the previous disk. If the format is recognized to be different, it determines the new format type and judges whether or not it can utilize formatted data of that type. If it is judged that it can utilize the new disk, navigation with a program corresponding to the new disk can be started. If it is not possible to utilize the new disk, the unit notifies the user of that fact. After the program is started, before any disk change, a route to the input destination is arithmetically determined according to the position coordinates and route search conditions dictated by destination and points to be passed. Because the disk can be replaced while retaining in memory information for the determined route, it is possible to omit procedures for calculation of destination, route and the like when the disk is replaced, so that complicated procedures at the time of disk replacement can be reduced. Additionally, by providing a means for judging the progress of route guidance before the disk replacement, if it is judged that the vehicle has already reached a destination, a guidance point or the like, only the interval of the determined route for which guidance has not yet been provided need be searched and guidance therefor provided, so that unnecessary route search processing can be eliminated and search time can be reduced.

Detailed Description Paragraph Right (22):
The systems described above include the type in which only data is stored in a CD-ROM and application and OS programs are stored in a ROM of the central processing unit as shown in FIG. 13(b) and the type in which both programs and data are stored in a CD-ROM and programs are written in a program memory area of a RAM or a flash memory of the central processing unit as shown in FIG. 13(a) while the same version program is used. However, in the latter type whose program(s) has been updated, after the processing of step S23, needless to say, reading and writing of the updated program into program memory are necessary. Although the guidance route is usually memorized with a road number, an intersection number or the like as described previously, position information for a destination, a roundabout point and the like is memorized in the form of coordinate values, therefore the memorized coordinate values can be retained as is for later use without being deleted in step S25. The same is true for other information which can be used as is, including search conditions such as express road priority, toll road priority, and the like.

Detailed Description Paragraph Right (23):
The CD-ROM data comprises, as shown in FIG. 7 for example, disk management information, loader programs, and data for navigation. The disk management information includes identification of CD-ROM type (either navigation, music, video, or the like), classification Nos. of local version, nation-wide version, sightseeing version, leisure version, genre, and the like, update No. and the like. In the case of a navigation program, if it is a local version, by providing an appropriate area with coordinates, it is possible to identify an area on the basis of the coordinates. As explained previously, the overall navigation program includes a map drawing program, a route search program, a route guidance program, a current position calculation program, a destination setting operation control program and the like, and is divided into an application section and an OS section. Data includes map data, search data, guidance data, map matching data, destination data and the like.

Detailed Description Paragraph Right (24):
In the CD-ROM shown in FIG. 8, its address space is allocated such that an index is stored beginning at address d, program A is stored beginning at address a, program B is stored beginning at address b and data (A) is stored beginning at address c. The index information comprises data address, data size, program number (n) and program address information of each type. The program address information of each type includes corresponding type (e.g., A, B, . . .), version, program address, and program size. This index corresponds to disk management information shown in FIG. 7 and the corresponding type corresponds to the classification number. Thus, program A is a program of the corresponding type A which is read into the central processing

unit and activated therein and program B is a program of the corresponding type B which is read into the central processing unit and activated therein. Both the programs can utilize data (A) of the type A. Namely, for data (A), the program B which can be activated in the type B such that navigation program using data (A) produced for the type A can be serviced for the type (B). Thus, if corresponding to this type A CD-ROM, the loader program in the central processing unit (ECU) is equipped with a function capable of reading the index and recognizing the address and size of the program A, if the index is read as shown in FIG. 8(a), next the program A is read and stored in the program memory (second RAM in FIG. 1), so that route search and route guidance can be executed utilizing data (A) of the type A. Likewise, if the CD-ROM is of the type B and if the loader program in the central processing unit is equipped with a function capable of reading the index and recognize the address and size of the program B, if the index is read as shown in FIG. 8(b), next the program B is read and stored in the program memory (first RAM 42 in FIG. 1), so that route search and route guidance can be performed with the data (A) of the type A by activation of the program B of the type B. Thus, both types of the CD-ROM can be commonly used. For example, by using a CD-ROM containing the program A, the program B and data (B) of the type B in the type A central processing unit, it is possible to execute route searching and route guidance with data (B) of the type B by first activating program A of the type A.

Detailed Description Paragraph Right (26):
FIG. 10 is an example of construction of a CD-ROM lacking a stored index. Version and program size for both the program A and the program B are stored as management information. Corresponding to such a CD-ROM, program reading addresses are set in the loader program of the central processing unit. For example, in the loader program of the central processing unit of the type A, the program A is read from the address as shown in FIG. 10(a). First, management information is read and stored in the program memory. Subsequently, according to the program size specified in the management information, a program is read and stored in the program memory. By activating the program A, navigation using data (A) of the type A is conducted. On the other hand, the loader program of the central processing unit of the type B functions to read the program B from the address b as shown in FIG. 10(b). First, management information is read and stored in the program memory. Subsequently, according to the program size identified by the management information, the program is read and stored in the program memory. By activating this program B, navigation using data (A) of the type A is conducted. Even in this construction, by comparing the version as identified in the management information with that in the program memory, whether or not the program should be updated may be determined.

Detailed Description Paragraph Right (27):
FIGS. 11(a) and 11(b) illustrate utilization of the CD-ROM by the central processing unit of the type A and that of the type B, respectively. FIG. 11(a) shows a case in which data (A) of the type A is memorized and a CD-ROM storing the program A for use in the central processing unit of the type A and the program B for use in the central processing unit of the type B is used. FIG. 11(b) shows the case in which data (B) of the type B is memorized and a CD-ROM storing the program A for use in the central processing unit of the type A and the program B for use in the central processing unit of the type B is used. In the central processing unit, a loader program and a program memory which read the program of its type from the CD-ROM are stored. The CD-ROM contains the programs A and B of respective types A and B, each comprising an application section including a map drawing program, route search program, route guidance program, a current position calculation program, and a destination setting operation control program and an OS section. The CD-ROM also stores all data necessary for operation of the navigation system, including files of map data, search data, guidance data, map matching data, destination data and the like, commonly used by each of the stored programs. As a result, it is possible to use a CD-ROM of any type so that the utilization and flexibility of the navigation system are enhanced.

Detailed Description Paragraph Right (30):
FIG. 15 shows a preferred embodiment of a navigation system according to the present invention as including an arithmetic operation control section 60. This arithmetic operation control section 60 is connected to a display unit 70, which functions as a touch panel providing operation switches, and a switch control section 67 for controlling input from the touch panel of the display unit 70. The arithmetic

operation control section 60 corresponds to the previously mentioned central processing unit 4 and the display unit 70 corresponds to the previously described display 12.

Detailed Description Paragraph Right (31):
Switches for calling up a menu screen of the navigation system, switches for adjustment of air conditioning, switches for operating audio equipment and other switches may be provided in the display screen(s) of display unit 70. Operation of one of these switches serves to present a corresponding menu screen. The screen displayed on the touch panel has a hierarchical structure so that the menu screen of highest level is first presented.

Detailed Description Paragraph Right (32):
On a menu screen of the navigation system, for example, keys for destination setting, place name detection and the like are displayed. If a destination setting key is specified, a menu with keys for specifying a ski area, a golf course or the like is displayed as a lower level screen and, by keying in selections from this and subsequent menu screens, the lowest level screen is eventually displayed.

Detailed Description Paragraph Right (33):
The arithmetic operation control section 60 is connected to a disk control unit 71 for reading an external information recording medium 59 (one of disks 37a, 37b) selected by current position detection section 62 and a recording medium selecting unit 72, and to a disk control unit 71. The current position detection section 62 obtains data from a GPS (global positioning system) receiver 51, a direction sensor 52 and a distance sensor 53 and utilizes this data to determine the current position of the vehicle. The current position detection section 62 corresponds to the previously described current position detecting unit 2. The GPS receiver 51, the direction sensor 52, and the distance sensor 53 correspond to the aforementioned GPS receiver unit 21, the absolute direction sensor 24, the relative direction sensor 25 and the distance sensor 26, respectively. GPS receiver 51 is a unit for receiving signals from an artificial satellite and for obtaining various information such as signal transmission time, position information for the receiver, receiver moving speed and receiver moving direction.

Detailed Description Paragraph Right (34):
Additionally, although not shown, current position detection section 62 is provided with a beacon receiver which is a unit for receiving a signal transmitted from a transmitter installed at a particular point and can obtain specific VICS information, namely information about vehicle travel such as traffic jam information, current position information and parking information.

Detailed Description Paragraph Right (38):
As output for voice guidance from the navigation system, the vehicle is equipped with a speaker 55.

Detailed Description Paragraph Right (39):
External information storage medium 59 contains map data, intersection data, node data, road data, photo data, registration point data, guidance point data, destination data, telephone number data, address data and the like, necessary for route guidance, i.e. serves as a data base containing all data necessary for operation of the navigation system. The external information storage medium 59 corresponds to the aforementioned information storage section 3, and map data, intersection data, node data, road data, photo data, registration point data, guidance point data, destination data, telephone number data, address data and the like of the external information storage medium 59 correspond to the data stored in the information storage section 3 of the previously described embodiment.

Detailed Description Paragraph Right (40):
The external information storage media 59 include various types, for example, a nation-wide version CD-ROM 37a with nationwide map data, a local version CD-ROM 37b, with more detailed map data than the nation-wide version and covering only a part of the geographical area of the former, and a sightseeing CD-ROM with sightseeing information.

Detailed Description Paragraph Right (41):
The disk control unit 71 is connected to the recording medium selecting unit 72 and instructs the recording medium selecting unit 72 as to the external information recording medium 59 to be selected, either in correspondence to the current position of the vehicle or responsive to external input. Then, map information for the vicinity of the current position and information for route guidance are read from the selected external information recording medium 59.

Detailed Description Paragraph Right (43):
The arithmetic operation control section 60 comprises a map information storage section 69, a map drawing section 63A, a map management section 63, a screen management section 65, an input management section 66, voice output management section 68 and an overall management section 61 for managing each of the other sections. Then, the arithmetic operation control section 60 conducts a route search to determine a route from the current position to the destination by managing operation of each of its component sections, as in conventional navigation systems, and provides route guidance to the destination by voice and display.

Detailed Description Paragraph Right (44):
The map management section 63 manages the map information storage section 69 and the map drawing section 63A so as to provide map information corresponding to the current position from the current position measuring section 62 and to provide route information. The map management section 63 is connected to the disk control unit 71.

Detailed Description Paragraph Right (45):
The map information storage section 69 is connected to the disk control unit 71 and includes a first map information storage section 69A and a second map information section 69B. The respective storage sections memorize map information corresponding to the current position and route information for the determined route to the destination. Information stored in the first map information storage section 69A is managed by the map management section 63 which, although shown as a single RAM, may be a plurality of RAMS.

Detailed Description Paragraph Right (46):
The map drawing section 63A is designed to draw various pictures such as maps, roads, buildings, guidance symbols and the like.

Detailed Description Paragraph Right (47):
The screen management section 65 is connected to the display unit 70 and manages the map drawing section 63A so to output drawn picture data to the display unit 70.

Detailed Description Paragraph Right (49):
The voice output management section 68 outputs route guidance by voice during travel to the destination under control of the overall management section 61.

Detailed Description Paragraph Right (51):
First, the overall management section 61 of the arithmetic operation control section 60 surveys possible routes between the current position and a destination input from the switch input management section 67. This route search utilizes information from the external information storage medium 59 as in a conventional navigation system. The detected route information and map information corresponding to the current position are stored in the first map information storage section 69A provided in the map information storage section 69.

Detailed Description Paragraph Right (52):
Then, when the vehicle is started in motion, based on information stored in the map information storage section 69, a map (reduced to a specified scale) for the vicinity around the current position detected by the current position measuring section 62 is displayed on the display unit 70 under control of the screen management section 65.

Detailed Description Paragraph Right (53):
A map with the determined travel route traced thereon is displayed in the display unit 70 and is scrolled with travel of the vehicle so that vehicle position remains located in the center of the screen. Further, the indication of direction of travel on the display of unit 70 is an upward heading and, with a change in travel direction of the

vehicle, the map or the like displayed on the screen rotates so that the travel direction of the vehicle is always displayed as upward.

Detailed Description Paragraph Right (54):
Next, when route information and map information are output to the display unit 70 based on data received from the first map information storage section 69A, information from a second external information storage medium different from information of the external information storage medium first used in the first map information storage section 69A may be required. For example, if the external information storage medium is changed for example, from a nation-wide version CD-ROM 37a to a local version CD-ROM 37b or from a sightseeing version CD-ROM to a local version CD-ROM, or the like, route information and map information for that portion of the determined route ahead of the current location of a vehicle, contained in the first medium, are preliminarily memorized in the first map information storage section 69A. After such information is memorized in the first map information storage section 69A, reading from the first medium is stopped and the second medium is selected by the recording medium selecting unit 72 and read by the disk control unit 71.

Detailed Description Paragraph Right (55):
Then, based on the current location as detected by the current position detection section 62 and destination information memorized by the first map information storage section 69A, the detected route information and map information are memorized in the second map information storage section 69B. Responsive to a request for switching the display by an external input, the map information storage section 69 changes from the first map information storage section 69A to the second map information storage section 69B. As when information of the first map information storage section 69A is input to the display unit 70, depending on information memorized in the second map information storage section 69B, a map reduced to a specified scale for the vicinity around the current position of the vehicle is displayed on the display unit 70 under the management of the screen management section 65.

Detailed Description Paragraph Right (56):
A program loading routine which is basic to operation of this vehicle navigation system is illustrated in FIG. 16, wherein:

Detailed Description Paragraph Right (57):
(1) First, the disks contained in the CD changer are identified (step S51). That is, the CD changer is checked for presence of the nation-wide version CD-ROM 37a, the local version CD-ROM 37b, other music CD, or game-related CD and the like used for operation of the navigation system.

Detailed Description Paragraph Right (58):
(2) Next, whether or not a navigation type disk ("specialized disk") is contained in the changer is determined (step S52). Namely, it is determined whether or not either the nation-wide version CD-ROM 37a or the local version CD-ROM 37b is available.

Detailed Description Paragraph Right (59):
(3) If no navigation (map) CD is present in the changer, an alarm message, for example, saying "Insert a map disk" is displayed on the display unit 70 (step S59).

Detailed Description Paragraph Right (60):
(4) If navigation disks are present in the changer, whether or not there is a map containing the current location coordinates of the vehicle is checked as to all navigation disks loaded therein (step S53).

Detailed Description Paragraph Right (61):
(5) If there is no map available containing the current location coordinates, an alarm message, for example, saying "Load an appropriate local version disk" is displayed on a display screen of the display unit 70 (step S60).

Detailed Description Paragraph Right (62):
(6) Whether the map disk containing the current location coordinates of the vehicle is a local version CD-ROM or a nation-wide version CD-ROM is determined (step S54).

Detailed Description Paragraph Right (63):

(7) If no local version CD-ROM 37b is present in the changer but a nation-wide version CD-ROM 37a is available therein in step S54, a navigation program of the nation-wide version CD-ROM is read into and memorized in the map information storage section 69 (e.g., a flash memory) disposed in the navigation system so as to activate that program (step S61). Next, a message, for example, saying "Guiding by nation-wide version CD-ROM" is displayed (step S62).

Detailed Description Paragraph Right (64):
(8) If a local version CD-ROM 37b is present in step S54, whether or not a nation-wide version CD-ROM is available as another CD-ROM is checked (step S55). If no nation-wide version CD-ROM 37a exists, a navigation program of the local version CD-ROM is read and memorized in the map information storage section 69 of the navigation system so as to activate the program (step S57). Then, a message, for example, saying "Guidance by Local Version CD-ROM?" or the like is displayed (step S58).

Detailed Description Paragraph Right (66):
(9) Depending on the type of CD-ROM to be activated, map display processing is carried out to display an appropriate map on a display screen of the display unit 70 (step S63).

Detailed Description Paragraph Right (67):
In this manner, whether or not a CD-ROM loaded in the CD changer is a navigation ("specialized") disk is judged and, at the same time, whether or not the navigation disk contains map data including the current location coordinates is judged. Further, whether a nation-wide version CD-ROM or a local version CD-ROM 37b is available is judged and if a local version CD-ROM 37b is present in the changer, priority is given to use of the local version CD-ROM 37b.

Detailed Description Paragraph Right (68):
Next, program loading routine (2) to be used when the vehicle navigation system is equipped with a plurality of CD-ROMs will be described with reference to FIG. 17.

Detailed Description Paragraph Right (70):
(2) Whether or not a navigation ("specialized") disk is loaded in the changer is checked (step S72). Namely, whether or not a nation-wide version CD-ROM, a local version CD-ROM, or a sightseeing version CD-ROM is loaded is checked.

Detailed Description Paragraph Right (71):
If no specialized disk is loaded, an alarm message, for example, saying "Insert a specialized disk" is displayed on a display screen of the display unit 70 (step S82).

Detailed Description Paragraph Right (72):
(3) If specialized disks are loaded in the changer, whether or not there is a map containing the current location coordinates of the vehicle is checked as to all of the navigation disks (step S73).

Detailed Description Paragraph Right (73):
If there is no map including the current location coordinates (e.g., the nation-wide version CD-ROM is not loaded), an alarm message, for example, saying "Load a map disk of a corresponding area" is displayed on a display screen of the display unit 70 (step S83).

Detailed Description Paragraph Right (74):
(4) Whether there are a plurality of navigation disks containing the current location coordinates is checked (step S74).

Detailed Description Paragraph Right (75):
If only one navigation disk is loaded in the changer, the navigation program of that CD-ROM is read and memorized in the map information storage section 69 of the navigation system so as to activate that program (step S77).

Detailed Description Paragraph Right (76):
If there are two or more navigation disks, the types of these disks are displayed on a display screen of the display unit 70 (step S75) so that user can select the disk which he needs (step S76).

Detailed Description Paragraph Right (77):
(5) From among the types of the disks displayed on the display screen of the display unit 70, one disk is selected, and if the selected CD-ROM is a local version CD-ROM 37b, the navigation program of the local version CD-ROM 37b is read and memorized in the map information storage section 69 of the navigation system so as to activate that program (step S78). Then, a message saying "using local version CD-ROM 7" is displayed (step S79).

Detailed Description Paragraph Right (78):
If the selected disk is a nation-wide version CD-ROM 37a, the navigation program of the nation-wide CD-ROM 37a is read and memorized in the map information storage section 69 of the navigation system so as to activate that program (step S80). Then, a message saying "Using Nation-wide CD-ROM" is displayed (step S81). If the selected disk is a sightseeing version CD-ROM, as in the case of the nation-wide version CD-ROM 37a and the local version CD-ROM 37b, the navigation program of the sightseeing version CD-ROM is read and memorized in the map information storage section 69 of the navigation system so as to activate that program. Then, a message saying "Guidance by Sightseeing Version Disk" is displayed.

Detailed Description Paragraph Right (79):
(6) Depending on the type of CD-ROM to be activated, map display processing is performed to display the map on a display screen of the display unit 70 (step S84).

Detailed Description Paragraph Right (80):
In this manner, whether or not the disk contained in the CD changer is a navigation disk is judged and then, whether that navigation disk has map data including the current location coordinates is judged. If there are two or more disks having the current location coordinates, their disk names are displayed on the display screen of the display unit 70 and the user is invited to select one.

Detailed Description Paragraph Right (83):
(2) If YES is answered in step S101, whether or not the current position of the vehicle has approached or entered the geographical range of the local version CD-ROM 37b is judged (step S102).

Detailed Description Paragraph Right (85):
(4) Next, based on destination information, route setting conditions and passing point information in the nation-wide version CD-ROM 37a, a route search is conducted using data of the local version CD-ROM 37b (step S104).

Detailed Description Paragraph Right (86):
(5) Then, the result of the route search and map data for the vicinity of the current position are memorized in the second map information storage section 69B (step S105).

Detailed Description Paragraph Right (88):
(7) If YES is answered in step S106, changeover from the first map information storage section 69A to the second map information storage section 69B is output (step S107).

Detailed Description Paragraph Right (89):
(8) If NO is answered in step S106, there is no changeover from the first map information storage section 69A to the second map information storage section 69B and the routine returns.

Detailed Description Paragraph Right (92):
(2) If YES is answered in step S201, whether or not the current position of a vehicle is within a specified distance range for the local version CD-ROM 37b is judged (step S202).

Detailed Description Paragraph Right (93):
(3) If YES is answered in step S202, destination information and route information of the nation-wide CD-ROM 37a is requested (step S203). Then, the destination information and the route information are memorized in the first map information storage section 69A.

Detailed Description Paragraph Right (97):
(7) Map data for the vicinity around the current position and the results of the route search are memorized in the second map information storage section 69B (step S207).

Detailed Description Paragraph Right (99):
(9) If YES is answered in step S208, changeover from the first map information storage section 69A to the second map information storage section 69B is output (step S209).

Detailed Description Paragraph Right (100):
(10) If NO is answered in step S208, changeover from the first map information storage section 69A to the second map information storage section 69B is not output and the routine returns. During travel of the vehicle with guidance by a display based on the nation-wide version CD-ROM or the local version CD-ROM, a quite detailed map such as a residential map is sometimes requested. FIG. 20 shows a routine for changeover to a residential map disk having detailed map information responsive to such a request.

Detailed Description Paragraph Right (101):
(1) First, the current position coordinates of the vehicle are obtained (step S301).

Detailed Description Paragraph Right (102):
(2) Next, a residential map disk or a peripheral information CD-ROM is started (step S302).

Detailed Description Paragraph Right (103):
(3) Then, based on the obtained current position coordinates, map data for the area around the current position in the residential map disk is read (step S303).

Detailed Description Paragraph Right (104):
(4) Then, that map data is memorized in the second map information storage section 69B (step S304). Such processing is automatically conducted when the vehicle enters an area for which a residential map disk is available.

Detailed Description Paragraph Right (105):
A routine for residential map display will now be described with reference to FIG. 21.

Detailed Description Paragraph Right (106):
(1) If in the routine shown in FIG. 20, map data is memorized in the second map information storage section 69B (step S304), a check is made to determine completion of residential map information (step S401).

Detailed Description Paragraph Right (107):
(2) To notify the user the residential map data can be displayed on the screen, if YES is answered in the above-mentioned step S401, a switch for changeover to the residential map is displayed (step S402). For example, in this case, as shown in FIG. 22, a detail key 31, a residential map key 32, an all route key 33, and an enlarge key 34 are displayed on the display screen of the display unit 70. Here, any one of the detail key 31, the residential map key 32, the all route key 33 and the enlarge key 34 can be selected. If the residential map key 32 is selected, map information and route information based on the residential map disk memorized in the second map information storage section 69B is output and displayed.

Detailed Description Paragraph Right (108):
If the detail key 31 is continued to be pressed, as shown in FIG. 23, a screen including a scale bar is displayed. It is also possible to design the system so that display map information and route information based on the residential map disk is displayed if depression of the detail key 31 is further continued.

Detailed Description Paragraph Right (109):
Further, it is possible to display the display screen shown in FIG. 23 when the changeover switch for the residential map is displayed (step S402).

Detailed Description Paragraph Right (110):
According to another embodiment of the present invention, the navigation system searches to determine a route to an input destination and provides route guidance. In

this embodiment the navigation system includes: a plurality of map information storage means (CD-ROM 37a-37e) at least one of which contains map information (road map data or residential map data) for conducting route guidance following the determined route; range information extracting means (step SB5) for extracting the geographical coordinate range (coordinate range ZP) of the aforementioned map information from each of the plurality of the map information storage means; a current position detecting means (current position detecting unit 2, step SA2) for detecting the current position coordinates (current position data MP, guidance start point data SP) of the vehicle; map information selecting means(steps SB6, SB7, SB8, SB39, SB41, SB44, SB61) for selecting a map information storage means, for which the current position coordinates detected by the current position detecting means are contained in a geographical coordinate range extracted from the range information extracting means, from among the plurality of the map information storage means; and a read/display means (display 12, step SB13) for reading the map information from the aforementioned map information storage means selected by the map information selecting means and for displaying it.

Detailed Description Paragraph Right (111):
According to another embodiment of the present invention, the navigation system, as in the previous embodiment, searches map data to determine a route to an input destination and provides route guidance for following the determined route. The navigation system of this latter embodiment includes: a plurality of map information storage means (CD-ROMs 37a-37e), at least one of which contains map information (road map data or residential map data), for providing guidance along the determined route; category (field) information extracting means for extracting the category of the aforementioned map information from each of the plurality of the map information storage means; destination category detecting means (step SA4, step SB51) for detecting the aforementioned input category, purpose or genre of the destination; map information selecting means (step SB54) for selecting a map information storage means in which the category, purpose or genre corresponds to the category, purpose or genre extracted by the category information extracting means; and reading/display means (step SB13, display 12) for reading and displaying the aforementioned map information from the map information storage means selected by the map information selecting means.

Detailed Description Paragraph Right (112):
FIG. 24 shows the types of information which may be recorded on the CD-ROMs 37a-37e. In each of the CR-ROMs 37a-37e, a map data file 40a, an intersection ("crossing") data file 40b, a node data file 40c, a road data file 40d, a photo data file 40e, a destination data file 40f, a guidance point data file 40g, a detailed destination data file 40h, a destination reading data file 40I, a navigation program 40j, other data file 40k and a coordinate range 40m are contained. The map data file 40a is divided into two kinds of map data, i.e. road map data and residential map data.

Detailed Description Paragraph Right (113):
FIG. 25 shows a map enlarged to maximum scale, displayed on the display 12 on the basis of road map data. This road map data includes map data covering nation-wide roads and map data covering only the roads in a block which is obtained by dividing the whole country into several blocks. The ranges for this road map data differ between the respective CD-ROMs 37. Namely, a certain CD-ROM 37 is a nation-wide version in which data only for major roads is recorded and another CD-ROM 37 is a local version containing data for roads in a single, smaller area (e.g., Kanto area, Chubu area, and the like).

Detailed Description Paragraph Right (114):
FIG. 26 shows a residential map based on data recorded in the CD-ROM 37, displayed on the display 12. This residential map covers a particular geographical area such as a major city, a local city, a town, village or the like. That is, the road map is a relatively simplified map showing only roads necessary for navigation whereas the residential map is a locally limited map in which houses, buildings, roads, rivers and the like are described to an accurate reduction scale. In this residential map, it is possible to recognize a shape of a building, facility, bridge or the like with coordinates and appearance of shape and the like of a part or all of the buildings, land features and the like displayed on the screen. For example, the shapes of all buildings in a certain section surrounded by roads, a river, pond and the like may be displayed.

Detailed Description Paragraph Right (115):
The road map data recorded in each of the CD-ROMs may include a plurality of maps of the same area of different scales or may include a single road map of the minimum reduced scale. Likewise, the residential map data may include data for a single reduced scale of the same area or may include a plurality of map data sets, each having different reduced scales. In the display of a road map based on road map data as shown in FIG. 25, roads are identified by lines having a different size and color. For major buildings, facilities and the like, a symbol mark is shown at its center. Although graphic representation of other information is omitted, geographical information such as building and facility names, major road names, geographical names of cities, towns and villages, and traffic restriction marks such as one-way only are displayed.

Detailed Description Paragraph Right (116):
On the other hand, the residential map is a map of an enlarged scale as compared to the road map of the minimum reduced scale as shown in FIG. 25 or a map of the same reduced scale. In this residential map, the ratio of respective road widths to lengths is the same as the ratios of the actual roads and further sidewalks and footbridges are also displayed. Additionally, the shapes of rivers, buildings, facilities and the like are represented with the same ratio as that of the actual dimensions.

Detailed Description Paragraph Right (118):
The destination data file is data for locations which may serve as destinations such as the location, name and the like of places and facilities such as major sightseeing spots, buildings, and corporations and factories registered in the yellow pages. The guidance point data file contains guidance data for providing information regarding road-side markers and signs and instructions for travel through an intersection. The detailed destination data file is data providing further details of a destination memorized in the above-mentioned destination data file. The destination reading data file is listed data for retrieving a listed destination memorized in the above destination data.

Detailed Description Paragraph Right (119):
The house shape data file contains data identifying building shape and identification data for building shapes for indicating the building shape in correspondence with the above-mentioned residential map data. The building shape mentioned here refers to a plan view of a place sectioned in plan view such as an actual building, a facility, a road, a river and the like, or to three-dimensional appearance of a place represented in two dimensions by a perspective view or the like. Although building shape has been referred to for convenience, shape data may be provided for such various facilities, land features, roads, lakes, and the like. The building shape data includes coordinates of each corner of the external shape of the above mentioned building, external information about the horizontal plane shape, three-dimensional shapes and the like of a building and internal information specific to the building. For example, such internal information may include residential address, name, owner's name, telephone number, work type, neighboring road data and the like. This building shape data, the content and display method for the above mentioned residential map data are described in detail in the specifications and drawings of Japanese Patent No. Sho 7-254274, No. Sho 7-258006 and a patent "Navigation System" filed by the same applicant in Oct. 31, 1995, the teachings of which are incorporated herein by reference.

Detailed Description Paragraph Right (120):
The navigation program stored in each of the CD-ROMs 37 is used for conducting a route search from the current position to a destination based on road map data memorized in an appropriate CD-ROM 37. Further, if the appropriate CD-ROM 37 is a CD-ROM to be used for sightseeing or another designated purpose, the navigation programs also include a program corresponding to that particular purpose also. For example, the sightseeing CD-ROM 37 contains a program for notifying a user of sightseeing information relevant to each region. This navigation program is read from the CD-ROM 37, written into the first RAM 43 and executed by the CPU 40. That is, the first RAM functions as a shadow RAM.

Detailed Description Paragraph Right (121):

Other data files which may be stored in the CD-ROM 37 include an address data file for retrieving the above-mentioned destination based on its address, a telephone number list file for retrieving the above-mentioned destination from its telephone number, a data file for retrieving the destination based on information registered by a user such as customer name or a person having a business connection, and the like. Further, the coordinate range 80 m is data recording the latitude and the longitude of a road located on the northernmost end, the southernmost end, the eastern-most end and the western-most end of the geographical area for each road covered by the above-described road map data. That is, the coordinate range 80 m indicates the geographical coordinate range of road map data to be recorded in each of the CD-ROMs 37a-37e.

Detailed Description Paragraph Right (122):
FIG. 27 shows part of a data group stored in the first RAM. A program stored in the aforementioned CD-ROM 37 is copied in a program area PL. Current position data MP is data for indicating the current position of a vehicle as detected by the current position detecting unit 20. Absolute direction data ZD is data for indicating the north-south direction and is based on information from the absolute direction sensor 24. Relative directional angle data D.theta. is data for the angle formed by the travel direction of the vehicle relative to the absolute direction data ZD, and obtained on basis of information from the relative direction sensor 25.

Detailed Description Paragraph Right (123):
Travel distance data ML is the distance travelled by the vehicle and is obtained on basis of data from the distance sensor 26. Current position information PI is data concerning the current position and which is input through the beacon receiver unit 22, the data transmitting/receiving unit 27 or the data transmitting/receiving unit 39.

Detailed Description Paragraph Right (124):
Registered destination data TP is data registered by a user, concerning the destination, such as the coordinate position, name and the like of the destination. Likewise, final guidance point data ED is coordinate data on a map for a position in which the navigation operation is terminated. These data SP and ED are determined in step SAS of the routine shown in FIG. 29 and described later.

Detailed Description Paragraph Right (125):
Guidance start point data SP is the coordinates of the node nearest to the current position of the vehicle. The reason why this guidance start point data SP is memorized is that the current position of the vehicle (and current position data MP) may be within a site such as, for example, a golf course or a parking lot, and is not always on a guidance road. Likewise, guidance final point data ED is also the coordinates of a node nearest the registered destination (data TP). The reason why this guidance final point data ED is stored is that the registered destination data TP is not always for a location on a guidance road.

Detailed Description Paragraph Right (126):
Guidance route data MW memorized in the first RAM 43 is data indicating an optimum route to the destination, i.e. a recommended route obtained by route searching in step SA5. Respective roads in a road map memorized in the CD-ROM 37 have characteristic (identifying) road numbers. This guidance route data MW is a string of the aforementioned roads from the guidance start point identified by data SP to the final guidance point identified by data ED, and obtained in route search processing.

Detailed Description Paragraph Right (127):
Disk quantity data Ckm is data indicating the quantity of the CD-ROMs stored in the changer 5. Index information IL(CKm) is data indicating the category, purpose or genre to which a CD-ROM 37 stored in the changer 5 belongs. These categories (field, purpose or genre) of information relate to major destinations for navigation and include, for example: public facility genre, optionally including both nation-wide and local versions, i.e. government offices, hospitals, parks, police stations, and post offices; traffic facility genre including railway stations, crossings, airports, harbors, express road interchanges, parking areas, and service areas; cultural facility genre including shrines, temples, historically significant locations, ruins, and castles; amusement facility genre including zoos, botanical gardens, amusement parks, aquariums, karaoke houses, and game centers; sport/leisure facility genre

including fishing parks, diving spots, campgrounds, golf courses, and ski areas; lodging facility genre including hot springs and hotels; dietary facility genre including cafes, hamburger stands and restaurants; automobile facility genre including gas stations, and automobile sale/repair shops; and shopping facility genre including banks, cash corners, drug stores, department stores, book shops, music shops and clothes shops. In addition, these categories, purposes and genre mentioned here, i.e. the category, purpose and genre of a CD-ROM 37, include programs and data for simple games, Karaoke music, quizzes, music and movies.

Detailed Description Paragraph Right (128):
Each of the CD-ROMs 37 contains information for identifying its category, purpose or genre and this identification information is category out from the CD-ROM 37 and memorized as the index information IL (Ckm). Ckm pieces of such index information IL (Ckm) exist corresponding to the respective CD-ROMs 37. In other words, information concerning the category, purpose and genre of the CD-ROM is located at the Ckm position in the changer 5 as index information IL (Ckm).

Detailed Description Paragraph Right (129):
Coordinate range ZP (Ckm) is a copy of coordinate range 80 m written and stored in the CD-ROM for navigation. This coordinate range ZP (Ckm) is the maximum value and the minimum value of the latitude and longitude of a road map recorded in each of the CD-ROMs. This value ZP serves to clearly give the geographical range covered by the road map in each CD-ROM intended for use in navigation. Ckm pieces of data for this coordinate range ZP exist corresponding to each CD-ROM 37, like the index information FIG. 28 shows information and data to be written into the second RAM 41. An accumulated use frequency LK(OP) is memorized in this second RAM 41. This accumulated use frequency LK(OP) indicates the number of times each CD-ROM has been used in the navigation system. The variable (OP) is a variable identifying the accumulated use frequency LK in terms of category (category, purpose or genre) and indicates the type of the category. For example, OP=1 indicates a category for golf courses and OP=2 indicates a category for sightseeing locations.

Detailed Description Paragraph Right (130):
FIG. 29 is a flow chart of a routine for the overall operation of the navigation system, which routine is executed by the CPU 40. Execution of the routine of FIG. 29 is started by turning on the power and is terminated by turning off the power, i.e. on/off of the power of the navigation system or on/off of the engine start key (ignition switch) of the vehicle. In this routine, first, the CPU 40, the RAM 42, the picture memory 44 and the like are initialized (step SA1). Then, current position processing (obtaining the current position, etc.) (step SA2), CD-ROM 37 processing (content recognition, etc.) (step SA3), destination processing (destination setting, etc.)(step SA4), route processing (route search, etc.) (step SA5), guidance/display processing (step SA6) and other processing (step SA7) are carried out repeatedly.

Detailed Description Paragraph Right (131):
In the current position processing (step SA2), on the basis of signals received from a plurality of satellites, the coordinate position of each satellite, radio transmission time of the satellite and radio reception time by the GPS receiver unit 21 are identified. Then, according to those pieces of information, a distance to each satellite is calculated and further, according to the distance to each satellite, the coordinate position of the vehicle is calculated and then the current position thereof is obtained. This obtained coordinate position of the vehicle is stored in the first RAM 43 as the current position data MP. This current position data MP may be corrected by information input from the beacon receiver unit 22 or the data receiver unit 23.

Detailed Description Paragraph Right (132):
On the basis of the absolute direction data, the relative direction data and the traveling distance data, arithmetic operation for specifying the current position of the vehicle is conducted. The current position obtained by this arithmetic operation is compared with the map data in the external data and corrected so that the current position on the map screen is displayed correctly. By this correction, even when the GPS signal cannot be received because the vehicle is traveling in a tunnel or the like, it is possible to accurately obtain the current position of the vehicle.

Detailed Description Paragraph Right (133):

In the CD-ROM processing (step SA3), the content of the CD-ROM 37 stored in the changer 5 is recognized and a CD-ROM for use in display and processing in the navigation system is automatically selected. This CD-ROM 37 processing is executed when the power is turned on and, after the power is turned on, as described later, is executed only when a new CD-ROM 37 is stored in the changer 38. At other times, this processing is jumped over.

Detailed Description Paragraph Right (134):
In the destination processing (step SA4), on a road map or a residential map shown on the display 12, a coordinate position is specified by a user or a destination is specified by the user by selecting it from a destination list of each item displayed on the display 12. Once the destination has been specified by the user, the central processing unit 1 memorizes information data for the coordinates or the like of the destination in the first RAM 43 as the registered destination data TP. This information data for the coordinates or the like of the destination includes the building shape data of the residential map, vehicle stops en route to the destination and the like. This destination processing is jumped over if there is no change by the setting of a new destination or a new vehicle stop.

Detailed Description Paragraph Right (135):
In the route search processing (step SA5), an optimum route from the guidance start point identified by data SP to the final guidance point identified by data ED, through any stops, is determined. The terminology "optimum route" as used herein has reference to a route which allows reaching of the destination in the shortest time or by the shortest distance or, if an express road is used, a route which allows reaching of the destination in the shortest time or by the shortest distance using the express road or a route which allows reaching of the destination or a vehicle stop by travel on the widest roads available. The guidance start point identified by data SP is the same as the initial current position identified by data MP or nearest the current position. If the current position of the vehicle deviates from a guidance route, an optimum route from the current position to which the vehicle has deviated to the final guidance point, through any designated vehicle stop, is automatically searched.

Detailed Description Paragraph Right (136):
In the aforementioned guidance/display processing (step SA6), a guidance route obtained by the route search processing (step SA5) is displayed as a map screen on the display 12 with a bold line of red, blue or other conspicuous color. Guidance information is audibly announced from the speaker 16 and the vehicle and guidance information is displayed in the map screen of the display 12. For pictures indicating the guidance route, road map data around the current position or residential map data around the current position is used. Changeover between the road map data and the residential map data is determined by the distance remaining to a guidance point (destination, vehicle stop, intersection or the like), the velocity of the vehicle, whether the vehicle is outside or inside of a representable area, or switch operation. Further, in the vicinity of a guidance point (destination, vehicle stop location, intersection or the like), an enlarged map of the vicinity of a guidance point is displayed. Instead of a road map, it is permissible to display a simplified guidance route in which only minimum information about the guidance route and destination or the direction to a stopping place and current position and the like is displayed with omission of other geographical information.

Detailed Description Paragraph Right (138):
The subroutine illustrated in FIG. 30 provides for selection of a suitable CD-ROM 37 from among the plural CD-ROMs stored in the changer 5. First, whether the power has been turned on by the CPU 40 or a new CD-ROM 37 has been placed in the changer 5 is judged (step SB1). The judgment as to whether the power is turned on is based on the detected state of the aforementioned navigation system power or of the vehicle start switch. The judgment as to whether a new CD-ROM 37 has been installed in the changer 5 is based on whether or not the changer 5 door is opened or closed and whether a CD-ROM 37 is loaded on a tray thereof. This is detected by a change of the contact switch provided on each tray with a passage of time. More specifically, the CPU of the data transmitting/receiving section 39 monitors the state of the contact switch of each tray at each time interval of a specified duration and if the state of any contact switch has changed, the local CPU of the data transmitting/receiving section 39 transmits information to the CPU 40 through the I/O data bus 28 and the communication

interface 47 by a method such as interruption and insertion of a new CD-ROM is thereby detected.

Detailed Description Paragraph Right (140):
Then, Ckm CD-ROMs 37 in the changer 5 are successively loaded on an optical head of the data transmitting/receiving section 39 by means of a loading device (not shown) disposed in the changer 5. Next, from the photo data file or the destination data file memorized in each of the CD-ROMs 37, information identifying the category (category, purpose or genre) or type is extracted and stored in the first RAM 5 as the index information IL (Ckm) (step SB3).

Detailed Description Paragraph Right (141):
The major objective of navigation registered for each CD-ROM 37, may be a golf course or a sightseeing location such as shrine or temple, such that the destinations thereof may be diversified. Thus, as described above, the index information IL (Ckm) is extracted from storage data contained in each CD-ROM and the major destination of each CD-ROM is thereby identified.

Detailed Description Paragraph Right (142):
The CD-ROMs usable in this system include non-navigation specialized disks such as for games, karaoke or the like. The index information IL (Ckm) is also read from such a non-navigation specialized CD-ROM and may be preliminarily stored. That is, in the CD-ROM 37, the index information for judging the category (category, purpose or genre) is stored. Then, the index information of that CD-ROM 37 is copied as the index information IL (Ckm) within the first RAM 43. Consequently, the index information IL (Ckm) is copied rapidly.

Detailed Description Paragraph Right (144):
If the reading of the index information IL (Ckm) from Ckm CD-ROMs 37a-37e is completed, the presence of a navigation CD-ROM stored in the changer 5 is determined based on the aforementioned index information IL (Ckm) (step SB4). This is because if the CD-ROM 37 stored in the changer 5 is not a navigation CD-ROM, the navigation operations of route searching and the like cannot be implemented.

Detailed Description Paragraph Right (145):
Therefore, if it is judged that no navigation CD-ROM 37 is stored in the changer 38 (NO in step SA4), the CPU 40 displays an alarm message saying "Install Navigation Disk" on the screen of the display 12 (step SB15). It is also possible to emit an aural alarm from the speaker 16 together with this displayed alarm message. Then, after a message saying "forcible termination" is displayed on the screen of the display 12, the entire power of the navigation system is automatically turned off (step SB17). This power off processing of step SB17 may be omitted. Instead of this forcible termination, it is permissible to repeat the processing of step SB15 or to return to the main routine of FIG. 29.

Detailed Description Paragraph Right (146):
If YES is the answer in step SB4, indicating that a navigation CD-ROM 37 disk is stored in the changer 5, each coordinate range 80 m memorized in that navigation CD-ROM 37 is read in the changer 5 and stored in the first RAM 43 as the coordinate range ZP (Ckm) of the CD-ROM 37 (step SB5). That is, the geographical range of road map information stored in the CD-ROM 37 is identified.

Detailed Description Paragraph Right (147):
Based on the read coordinate range ZP (Ckm) and the current position data MP detected in the aforementioned step SA2, a judgement is made as to whether or not a CD-ROM 37 disk containing road map data including the current position coordinates of the vehicle is present in the changer 5 (step SB6). If a CD-ROM 37 containing the current position coordinates of the vehicle is not present in the changer 5 (NO in step SB6), an alarm message saying "Install a Map Disk of an Appropriate Area" is displayed on the screen of the display 5. That is, the user is informed that no CD-ROM 37 with road map data which can indicate the current position of the vehicle exists in the changer 5 (step SB16). In this case also, it is permissible to issue an audible alarm from the speaker 16.

Detailed Description Paragraph Right (148):

On the other hand, if a CD-ROM 37 in which road map data including the current position coordinates is present within the changer 5, the routine next determines whether that CD-ROM 37 containing the current position coordinates is a local version (step SB7). This judgment is based on the value of the coordinate range ZP (Ckm). If no local version CD-ROM 37 is present in the changer 5 (NO in step SB7), it is judged that only a nation-wide version CD-ROM 37 is present in the changer 5.

Detailed Description Paragraph Right (149):
Then, that nation-wide version CD-ROM 37 disk is selected and the program for navigation stored in that nation-wide CD-ROM 37 is read by the data transmitting/receiving section 39 and copied into the program area PL of the first RAM 43 (step SB19). A message reading "Guidance by Nation-wide Version" is then displayed on the screen of the display 12 (step SB20). On the other hand, if any local version CD-ROM 37 is stored in the changer 5, the routine next determines whether or not a nation-wide CD-ROM 37 is also stored in the changer 5 (step SB8). Then, if it is judged that the nation-wide version CD-ROM 37 is also stored in the changer 5, a message reading "Guidance by Local Version is Acceptable?" and the words "YES" and "NO" are displayed (step SB9) and the user is thereby invited to decide whether or not guidance by data of the local version is acceptable (step SB10).

Detailed Description Paragraph Right (150):
If "approval" by input of "YES" is input by a user through the touch switch 11 or by silent approval through leaving the touch switch inoperative for a specified interval of time (YES in step SB10), a CD-ROM 37 in which a local version road map data is stored is selected from the trays of the changer 5. Then, the navigation program of that local version CD-ROM is copied into the program area PL of the first RAM 43 (step SB11). After that, a message saying "Guidance by Local Version Disk" is displayed on the screen of the display 12 (step SB12).

Detailed Description Paragraph Right (151):
However, if "NO" is the answer in step SB10 or other indication of disapproval is input by the user, a nation-wide version CD-ROM 37 in the changer 5 is selected. Then, its program is copied into the program area of the first RAM 43 (step SB19) and a message saying "Guiding by Nation-wide Version" is displayed on the screen of the display 12 (step SB20).

Detailed Description Paragraph Right (152):
If the program of a CD-ROM 37 is copied into the program area PL in step SB11 or step SB19, the road map or the residential map is displayed on the screen of the display 12 on the basis of the current position data MP of the first RAM 43 so that the current position of the vehicle is located in the center of the screen of the display 12 (step SB13). Then, the "CD-ROM processing" subroutine shown in FIG. 30 is terminated and the processing is returned to the main routine shown in FIG. 29.

Detailed Description Paragraph Right (153):
As described above, according to this embodiment, the presence of a navigation CD-ROM stored in the changer among a plurality of CD-ROMs 37 is automatically judged and if a navigation CD-ROM 37 is stored, either the nation-wide version or the local version CD-ROM 37 is automatically selected. Thus, the procedures of selecting of the CD-ROM 37 manually and of confirming of the contents of the selected CD-ROM 37 can be eliminated.

Detailed Description Paragraph Right (155):
First, as described above, whether or not the power has been turned on and whether or not a new CD-ROM 37 has been installed in the changer 5 is judged (step SB1). The quantity (Ckm) of the CD-ROMs stored in the changer 5 is judged by the local CPU in the data transmitting/receiving section 39. Next, information concerning the category (category, purpose or genre) or the type of each CD-ROM is extracted and stored in the first RAM 43 as the index information IL (Ckm) (step SB3). Whether or not any navigation CD-ROM 37 is stored in the changer 5 is judged on the basis of the aforementioned index information IL (Ckm) (step SB4).

Detailed Description Paragraph Right (156):
Next, the coordinate range 80 m indicating the geographical range of the road map data memorized in the CD-ROM 37 is read from each of the navigation CD-ROMs 37 in the

changer 5 (step SB5). Whether or not a CD-ROM 37 containing road map data including the current position coordinates of the vehicle is present in the changer 5 is determined (step SB6). If no CD-ROM 37 containing the current position coordinates of the vehicle is present in the changer 5 (NO in step 6), an alarm message "Install a Map Disk of Appropriate Area" is displayed on the screen of the display 12 (step SB16).

Detailed Description Paragraph Right (157):
In step SB6, if it is judged that a CD-ROM 37 containing road map data including the current position coordinates is present in the changer 5, it is next determined whether or not two or more such CD-ROMs are present in the changer 5 (step SB30). Here, if two or more CD-ROMs are stored therein, whether or not any local version CD-ROM 37 exists in the plurality of the stored CD-ROMs is judged (step SB7). This judgment is conducted using the coordinate range ZP (Ckm).

Detailed Description Paragraph Right (158):
In step SB7, if it is judged that any local version CD-ROM is stored in the changer 5, a confirmation message "Navigation with Local Version is Acceptable?" and the words "YES" and "NO" are displayed on the screen of the display 12 (step SB9) to invite a user to select YES or NO (step SB10).

Detailed Description Paragraph Right (159):
If "approval" or "YES" is input by a user through the touch switch 11 or by silent approval indicated by the touch switch 11 remaining inoperative for a specified interval of time (YES in step SB10), a CD-ROM 37 in which a local version road map data is stored is selected from the trays of the changer 5. Then, the navigation program of the selected CD-ROM is copied into the program area PL of the first RAM 43 (step SB11). After that, a message "Guidance by Local Version Disk" is displayed on the screen of the display 12 (step SB12).

Detailed Description Paragraph Right (160):
If the navigation program of a local version CR-ROM 37 is copied into the program area PL of the first RAM 43, the road map or the residential map is displayed on the screen of the display 12 on the basis of the current position data MP of the first RAM 43 so that the current position of the vehicle is located in the center of the screen of the display 12 (step SB13 in FIG. 10). Then, the "CD-ROM processing" subroutine is terminated and the processing is returned to the main routine shown in FIG. 29.

Detailed Description Paragraph Right (162):
If a nation-wide version CD-ROM 37 is present in the changer 5 (YES in step SB8), to ask the user whether or not the navigation operation may be executed using this nation-wide version CD-ROM 37, a message "Nation-wide Version Disk is Acceptable?" is displayed on the screen of the display 12 (step SB31)

Detailed Description Paragraph Right (163):
In response to this indication, if the user inputs "YES" indicating approval through the touch switch 11 or a silent approval by the touch switch 11 remaining inoperative for a specified interval of time (YES in step SB32), the nation-wide version CD-ROM 37 is selected in the changer 5. Then, the navigation program stored in this nation-wide version CD-ROM 37 is read by the data transmitting/receiving section 39 and copied into the program area PL of the first RAM 43 (step SB19). Then, a message "Guiding with Nation-wide Version" is displayed on the screen of the display 12 (step SB20).

Detailed Description Paragraph Right (164):
If the navigation program of the nation-wide version CD-ROM 37 is copied into the program area PL of the first RAM 43, the road map or the residential map is displayed on the screen of the display 12 on the basis of the current position data MP of the first RAM 43 so that the current position of the vehicle is located in the center of the screen of the display 12 (step SB13 in FIG. 10). Then, the "CD-ROM processing" subroutine is terminated and the processing returns to the main routine shown in FIG. 29.

Detailed Description Paragraph Right (165):
However, If NO is the answer in step SB8 or step SB32, index information IL of each of the remaining CD-ROMs 37 in the changer 5, which contain road map data including the

current position coordinates, is displayed on the display 12 (step SB33 in FIG. 10). This is the case where one or more CD-ROMs 37 are stored in the changer 5 and further the user does not want navigation processing by either the local version CD-ROM 37 or the nation-wide version CD-ROM 37.

Detailed Description Paragraph Right (166):
This displayed index information IL identifies the category of each of the navigation CD-ROMs 37 remaining in the changer 5. For example, if two CD-ROMs 37 whose main purpose is navigation to, respectively, a "golf course" and "sightseeing" are present, a message "golf CD-ROM 37 remains" or "sightseeing CD-ROM remains" or the like is displayed on the screen of the display 12 and output audibly.

Detailed Description Paragraph Right (167):
The user then operates the touch switch 11 to input a command selecting the desired CD-ROM 37 (step SB34). Whether or not there has been a selection by the user is judged depending on operation of the touch switch 11 (step SB35). If the touch switch 11 has been operated and a command for selection is input (YES in step SB35), a CD-ROM 37 corresponding to the selected category is selected by the changer 5. After that, the navigation program is copied from that selected CD-ROM 37 into the program area PL of the first RAM 43 (step SB36) and a message "Guidance by a Selected Application Disk" is displayed on the screen of the display 12 (step SB37).

Detailed Description Paragraph Right (168):
If the navigation program is copied into the program area PL of the first RAM 43, on the basis of the current position data MP of the first RAM 43, a road map or residential map is displayed on the screen of the display 33 such that the current position of the vehicle is in the center of the display 12 (SB13 in FIG. 10). Then, this "CD-ROM processing" subroutine is terminated and the processing is returned to the main routine in FIG. 29.

Detailed Description Paragraph Right (169):
However, if NO is the answer in step SB35 or if there has been no selection by the user, an arbitrary CD-ROM 37 is selected from the remaining CD-ROMs 37 in the changer 5. Namely, whether or not a sightseeing CD-ROM 37 whose navigation objective is a sightseeing spot such as a shrine, temple or the like exists among the remaining CD-ROMs stored in the changer 5 is judged (step SB39). If a sightseeing CD-ROM 37 is present, that sightseeing CD-ROM 37 is selected (step SB40).

Detailed Description Paragraph Right (170):
However, if no sightseeing CD-ROM 37 is present (NO in step SB39), whether or not any golf CD-ROM 37, whose main navigation objective is a golf course, is among the remaining CD-ROMs is judged (step SB41). If a golf CD-ROM 37 exists, that golf CD-ROM 37 is selected (step SB42).

Detailed Description Paragraph Right (171):
Further, if no golf CD-ROM 37 exists (NO in step SB41), whether or not a restaurant CD-ROM 37 whose main navigation objective is an eating facility, such as a restaurant or the like, is present among the remaining CD-ROMs is determined (step SB43). If a restaurant CD-ROM 37 is present, that restaurant CD-ROM 37 is selected (step SB44). However, if the category of a CD-ROM 37 remaining in the changer 5 is not restaurants (NO in step SB43), that remaining CD-ROM 37 is nevertheless selected (step SB45).

Detailed Description Paragraph Right (173):
If an arbitrary CD-ROM 37 is selected in steps SB39-SB45, the navigation program is copied from that selected CD-ROM 37 into the program area PL of the first RAM 43 (step SB36). Then, a message "Guidance with Selected Disk" is displayed on the screen of the display 12 (step SB37). Further, on the basis of the current position data MP of the first RAM 43, a road map or residential map is displayed on the screen of the display 12 with the current position of the vehicle located in the center of the screen of the display 12 (step SB13). This "CD-ROM processing" subroutine is then terminated and operation returns to the main routine shown in FIG. 29.

Detailed Description Paragraph Right (174):
As described above, according to this embodiment, whether or not a navigation CD-ROM 37 is contained in the changer among a plurality of CD-ROMs 37 contained therein is

automatically judged and if a navigation CD-ROM 37 is present, particular CD-ROMs 37 of respective categories are automatically selected according to an order of preference. Thus, the necessity of the user selecting a CD-ROM 37 manually and confirming the contents of the selected CD-ROM is eliminated thereby enabling more comfortable use of the navigation system.

Detailed Description Paragraph Right (175):
FIG. 33 shows a partial flow chart of a third embodiment of the "CD-ROM processing" subroutine, step SA3 in the main routine shown in FIG. 29, to be executed by the CPU 40. In this subroutine, a CD-ROM 37 depending on the category (category, purpose or genre) of a set destination is automatically selected. The remainder (first half) of the routine of the third embodiment is the same as that of the second embodiment shown in FIG. 31. Because the portion of the routine of the third embodiment shown in FIG. 31 is the same as the second embodiment, a description thereof is omitted. Additionally, in FIG. 33, reference numerals which are the same as in the first and second embodiments denote identical operative steps.

Detailed Description Paragraph Right (176):
If NO is the answer in step SB8 or in step SB32 in FIG. 31, the approximate content and type of the destination is displayed on the screen of the display 12 (step SB50). For example, a message "Is Your Destination a Golf Course?" or "Is Your Destination a Sightseeing Location?" is displayed. That is, the user is urged to input the approximate content of a destination. If NO is the answer to the above question, this means that no nation-wide version CD-ROM 37 is present among the CD-ROMs remaining in the changer 5 or, even if a nation-wide version CD-ROM 37 exists, the user does not permit use of the nation-wide version CD-ROM, as well as not permitting use of the local version CD-ROM 37.

Detailed Description Paragraph Right (177):
Depending on the screen of the display 12, the user operates the touch switch 11 and whether or not the type of a destination is selected is judged from the outline of the displayed destination (step SB52). If YES is answered in this step SB52 or if a selection is made by the user, whether or not a CD-ROM corresponding to the selected type of the destination exists in the changer 5 is judged (step SB53).

Detailed Description Paragraph Right (178):
If an appropriate CD-ROM 37 exists in the changer 5 (YES in step SB53), this appropriate CD-ROM 37 is moved to a position in which it can be read by the data transmitting/receiving section 39 in the changer 5 (step SB54). That is, selection of the CD-ROM 37 is executed. Then, the navigation program is copied from the selected CD-ROM 37 into the program area PL of the first RAM 43 (step SB36) and a message "Guidance with a Selected Application Disk" is displayed on the screen of the display 12 (step SB37).

Detailed Description Paragraph Right (179):
If the navigation program is copied into the program area PL of the first RAM 43, on the basis of the current position data MP of the first RAM 43, a road map or residential map is displayed on the screen of the display 12 such that the current position of the vehicle is in the center of the display 12 (step SB13). Then, this "CD-ROM processing" subroutine is terminated and the processing is returned to the main routine shown in FIG. 29.

Detailed Description Paragraph Right (180):
If NO is answered in step SB52 and in step SB53 or if the user does not enter an approximate destination or if, even with entry of an approximate destination by the user, the CD-ROM 37 which covers the approximate destination does not exist in the changer 5, a single CD-ROM is forcibly selected from the CD-ROMs 37 remaining in the changer 5 (step SB55).

Detailed Description Paragraph Right (181):
Although this selected CD-ROM 37 is, of course, a navigation CD-ROM37, the type is not specified. Thus, the CD-ROM 37 on the topmost tray of the remaining CD-ROMs 37 is sometimes selected.

Detailed Description Paragraph Right (183):

After this forcible selection from the remaining CD-ROMs, the navigation program is copied from that CD-ROM 37 into the program area PL of the first RAM 43 (step SB36) and further, a message "Guidance with a Selected Disk" is displayed on the screen of the display 12 (step SB37). Then, on the basis of the current position data MP of the first RAM 5, a road map or residential map is displayed on the screen of the display 12 such that the current position of the vehicle is in the center of the display 12 (step SB13). After that, this "CD-ROM processing" subroutine is terminated and then the processing returns to the main routine shown in FIG. 29.

Detailed Description Paragraph Right (184):
Meanwhile, the setting and judgment of the category of the destination in steps SB50-B52 may be decided on the basis of the genre (category, purpose or genre) of the selected destination and set in the aforementioned step SA4. The genre are as previously described.

Detailed Description Paragraph Right (185):
Genre is determined by selection of a destination when the destination is determined in step SA4. This type of genre determination is described in detail in the specifications and drawings of Japanese Patent No. Sho 6-329132 and Japanese Patent No. Sho 7-188014, the teachings of which are incorporated by reference herein. A CD-ROM 37 corresponding to a genre determined in this manner is selected in the aforementioned step SB54. Additionally, whether or not the field, purpose or genre of the destination has been set in the aforementioned step SB50 is also judged. Further, this "destination" may be either an intermediate stop or guidance final point as indicated by data ED or the like. Also, the current position judged in the aforementioned step SB6 may be the guidance start point indicated by data SP.

Detailed Description Paragraph Right (186):
As described above, according to the present invention, whether or not a navigation CD-ROM 37 is present in the changer among the plurality of the CD-ROMs 37 stored therein is automatically judged and if a navigation CD-ROM 37 is stored, a CD-ROM 37 corresponding to the category of a set destination is automatically selected. Thus, the selecting of the CD-ROM 37 manually by the user and the confirming of the content of the selected CD-ROM 37 is eliminated so that it is possible to more comfortably start the navigation operation.

Detailed Description Paragraph Right (187):
FIG. 34, in conjunction with FIG. 31, is a flow chart of a fourth embodiment of the "CD-ROM processing" subroutine which is step SA3 in the main routine shown in FIG. 29 to be executed by the CPU 40 of the navigation system of the present invention. In this subroutine, depending on the frequency of use each of the CD-ROMs 37, a CD-ROM 37 is automatically selected. The former half of the subroutine of this fourth embodiment is the same as in the above described second embodiment illustrated in FIG. 31. Because the portion of this subroutine shown in FIG. 31 is the same as in the aforementioned second embodiment, description thereof is omitted. Additionally, in this FIG. 34, the reference numerals which are the same as in the above-described first to third embodiments designate identical steps.

Detailed Description Paragraph Right (189):
That is, a CD-ROM 37 for a destination which has been used most frequently is automatically selected. Further, whether or not the CD-ROM 37 corresponding to the destination which was used most frequently is present in the changer 5 is judged (step SB61). If the CD-ROM 37 having the highest use frequency is not in the changer 5 (NO in step SB61), a CD-ROM 37 having the second highest use frequency is selected (step SB65). Then, whether or not the CD-ROM 37 having the second highest use frequency is in the changer 5 is judged again (step SB61). In this manner, the CD-ROM 37 in the changer 5 which has the highest use frequency is preferentially selected.

Detailed Description Paragraph Right (190):
Then, the accumulated use frequency LK (OP) of the application variable OP corresponding to the type of the destination of the selected CD-ROM 37 is incremented by 1 (step SB62). Whether this accumulated use frequency LK(OP) incremented by 1 has reached the maximum value which can be memorized in the second RAM 41 is judged (step SB63). If the maximum value is reached, the smallest value accumulated use frequency LK of the accumulated use frequencies LK(OP) is subtracted from each of the

accumulated use frequencies LK (OP) (step SB64). Consequently, overflow of the accumulated use frequency LK (OP) is prevented. In this case, it is also permissible to subtract an arbitrary value such as "2", "3" "4", . . . from each of the accumulated use frequencies LK (OP).

Detailed Description Paragraph Right (191):
The navigation program is then copied from the selected CD-ROM 37 into the program area PL of the first RAM 43 (step SB36). Further, a message "Guidance with a Selected Application Disk" is displayed on the screen of the display 12 (step SB37).

Detailed Description Paragraph Right (192):
Then, on the basis of the current position data MP of the first RAM 43, a road map or residential map is displayed on the screen of the display 12 in a manner that the current position of the vehicle is in the center of the display 12 (step SB13). This "CD-ROM processing" subroutine is then terminated and the processing is returned to the main routine shown in FIG. 29.

Detailed Description Paragraph Right (193):
If all the accumulated use frequencies LK (OP) are "0", it is permissible in step SB60 to forcibly select the topmost navigation CD-ROM 37 in the changer 5, other than the local version or the nation-wide version CD-ROM 37.

Detailed Description Paragraph Right (194):
It is also possible to substitute the processing of steps SB39-SB45 in the aforementioned second embodiment for the processing shown in FIG. 34 in the fourth embodiment. As a result in the second embodiment, after it has been determined that no local version or nation-wide version CD-ROM 37 can be selected, if the user does not select a CD-ROM 37 corresponding to the approximate content of one of the remaining CD-ROMs as displayed on the display 12, the accumulated use frequency LK (OP) used in the fourth embodiment is utilized and the CD-ROM 37 having the highest use frequency is automatically selected.

Detailed Description Paragraph Right (196):
As described above, according to the present invention, whether or not a navigation CD-ROM 37 is present among the plurality of the CD-ROMs 37 stored in the changer is automatically judged and if a navigation CD-ROM 37 is stored, an appropriate CD-ROM 37 is automatically selected from the plurality of the CD-ROMs 37 on the basis of the previous use frequencies of the CD-ROMs. Thus, the procedures of selecting the CD-ROM 37 manually by the user and the confirming of the content of the selected CD-ROM 37 are eliminated so that it is possible to more comfortably start the navigation operation.

Detailed Description Paragraph Right (197):
The present invention is not restricted to the foregoing embodiments but may be modified in various forms. For example, the destination to be processed in step SB50 and SB51 may be either a stop-over location or the guidance final point identified by data ED or the like. Further, the current position determined in step SB6 may be the guidance start point identified by data SP.

Detailed Description Paragraph Right (198):
Further, in each of the above described embodiments, the navigation program is read from the CD-ROM 37, written into the first RAM 43 and executed by the CPU 40. However, as is conventional, it is permissible that this data be memorized preliminarily in the first ROM 49 so that for any CD-ROM 37, the navigation operations such as route searching are executed with the same program.

Detailed Description Paragraph Right (199):
However, by providing a construction wherein an updated program is loaded into the first RAM 43 as described in connection with each of the above-described embodiments, even if the road map data construction method for a CD-ROM 37 is changed in the future so that such an updated version cannot be used effectively with the exiting program(s), that updated data can be used effectively by rewriting the CD-ROM program.

Detailed Description Paragraph Right (200):

Further, if all the screen indication data such as symbols for various information transmission, as displayed on the screen of the display 12, are memorized in the CD-ROM 37, when a new program is read in one of the described embodiments, the screen indication data is copied into the RAM altogether, so that it is always possible to execute the updated screen display method.

Detailed Description Paragraph Right (201):
Additionally, while in each of the above-described embodiments the coordinate range ZP (Ckm) written into the first RAM 43 is copied from the coordinate range 80 m preliminarily memorized in the CD-ROM 37, the coordinate range ZP (Ckm) may also be determined by arithmetic operation based on the road map data in the CD-ROM 37.

Detailed Description Paragraph Right (202):
Although the first ROM 49 and the second ROM 42 have been described for convenience, it is also permissible to use a single ROM. Further, the type of the first RAM 43 is not restricted and may be a dynamic RAM, a static RAM or a readable/writable RAM such as a memory card. In addition, in the current position detection unit 2, one or two of the GPS receiver unit 21, the beacon receiver unit 22 and the data receiver unit 23 may be omitted. The printer 13 may also be omitted.

CLAIMS:

1. A navigation system for conducting route searching and for providing route guidance to a destination, said navigation system comprising:

current position detection means for detecting a current position of a vehicle;

a replaceable information storage unit for storing map information;

destination input means for inputting the destination;

output means for outputting route guidance information for guiding travel; and

central processing means for executing the route search to determine a route to the destination based on the map information stored in said information storage unit, for obtaining route information for guidance along the route determined by the route search, for storing the retrieved route information, for outputting signals to the output unit for execution of route guidance for travel according to the determined route, for detecting replacement of said replaceable information storage unit by another information storage unit, for determining if route guidance to the destination has been completed and, in response to detection of the replacement of said replaceable information storage unit and a determination that guidance to the destination along the determined route has not been completed, for conducting a new route search to the destination based upon the map information in the another information storage unit.

2. A navigation system according to claim 1 wherein said replaceable information storage unit contains a program, wherein said central processing means includes an internal storage means for storing the program read from said replaceable information storage unit, and wherein said central processing means, responsive to replacement of the replaceable information storage unit with the another information storage unit containing a different program, reading and storing the different program in said internal storage means.

3. A navigation system according to claim 2 further comprising condition input means for inputting a search condition and wherein said central processing means executes the new route search based on the input search condition.

4. A navigation system according to claim 1 further comprising:

an internal storage medium included within said central processing means;

condition input means for inputting a search condition for storage in said internal storage medium; and

wherein said new route search is executed by said central processing means based on the stored search condition.

5. A navigation system in which a route to an input destination is searched and route guidance is carried out following the searched route, said navigation system comprising:

a plurality of map information storage means each containing at least one portion of stored map information for conducting route guidance following said route and external information of a plan-view shape and a three-dimensional shape of buildings and internal information relating to the buildings;

range information extracting means for extracting the geographical coordinate range of said map information from each of the plurality of the map information storage means;

current position detecting means for detecting the current position coordinates of a vehicle;

map information selecting means for selecting at least one of the plurality of map information storage means in which the current position coordinates detected by the current position detecting means is contained based upon the geographical coordinate range extracted by the range information extracting means from said plurality of the map information storage means; and

read/display means for reading said map information from said at least one map information storage means selected by said map information selecting means and displaying said map information.

6. A navigation system in which a route to an input destination is searched and route guidance is carried out following the searched route, said navigation system comprising:

a plurality of map information storage means each containing at least one portion of stored map information with geographical coordinates for conducting route guidance following said route;

range information extracting means for extracting a geographical coordinate range of said map information from each of the plurality of the map information storage means;

use frequency accumulating means for accumulating a use frequency of each of said map information storage means;

map information selecting means for selecting one map information storage means of the plurality of map information storage means based upon a highest use frequency accumulated by said use frequency accumulating means; and

read/display means for reading said map information from said one map information storage means selected by said map information selecting means and displaying said map information.

7. A navigation system according to claim 6 wherein said map information selecting means conducts said selection when the power of the navigation system is turned on and when said map information storage means is loaded or replaced.

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L11: Entry 47 of 86 File: USPT Dec 8, 1998

DOCUMENT-IDENTIFIER: US 5848373 A
TITLE: Computer aided map location system

Abstract Paragraph Left (1):
A computer aided map location system (CAMLS) provides correlation and coordination of spatially related data between a computer (PDA/PC/EC) and a set of printed maps typically printed on paper depicting surface features at desired levels of detail. A first set of constant scale printed maps substantially coincides with or is overprinted with equal area grid quadrangles of a first scale grid. The first scale grid quadrangles are identified by a first set of unique names. The PDA/PC/EC has a computer display or other computer output, a first database, and display subsystem. The first database includes the first set of unique names of the grid quadrangles of the first scale grid. The boundary lines of the respective first scale grid quadrangles are identified in the first database by latitude and longitude location. The display subsystem causes the display of a selected grid quadrangle or gridname on the PDA/PC/EC display in response to a user query. The displayed grid quadrangle or gridname is correlated with a grid quadrangle of a printed map from the first set of printed maps. The PDA/PC/EC may have access to a second database or multiple databases of latitude and longitude locatable objects (loc/objects) for display on selected grid quadrangles. Alternatively or in addition the PDA/PC/EC may incorporate a user location system such as a GPS location system for displaying the location and route of the CAMLS user on the display. Multiple level scales of grids and corresponding multiple sets of maps at the different scales are available. Communications links are provided between CAMLS computers and CAMLS users in various combinations.

Brief Summary Paragraph Right (1):
This invention relates to a new system for correlation and coordination of spatially related data between digital electronic media such as transitory computer displays or other computer outputs, and a variety of graphic and text media such as printed maps and other related "fixed" graphic and text media. The invention also provides for communication of the spatially related data between computer systems and between users in a variety of contexts and combinations. The invention has broad application for visual, intuitive, and other sensory correlation by the user of spatially related data such as location data for locatable objects between a user readable transitory computer display and other computer outputs, and a corresponding user readable printed map or other fixed media presentation of the same spatial area. The invention provides "intelligent" printed maps and other intelligent fixed media maps by incorporation of a digital electronic data dimension for data processing, computation, and communication.

Brief Summary Paragraph Right (2):
The invention also provides a novel grid system for user correlation of location data and other specified data between the diverse media. The spatially or geographically related data are correlated and coordinated internally by a computer according to the present invention with reference to a common geographical coordinate system such as the standard latitude/longitude location coordinate system. The spatially related data is correlated and coordinated intuitively by the user between human readable forms of the map using the new grid system and uniquely named grid quadrangles of constant scale. The invention permits correlation, coordination and communication of diverse data such as location data, geographical and GIS data, related text and alphanumeric data, mapping data, and visual, auditory, and other sensory data. Data may be derived from any state of the art available inputs to the system either local or remote,

internal or external, and the data correlated and coordinated in diverse media according to the invention can be made available in any state of the art outputs and can be communicated to any location.

Brief Summary Paragraph Right (3):
In a preferred form, the invention relates to a new computer aided map location system (CAMLS) using a coacting personal digital assistant (PDA) or other digital or electronic computer (EC) such as a digital microprocessor based personal computer (PC), workstation, or mainframe, and a set of detailed printed maps depicting surface features or mappable features for a specified geographical area, typically a set of printed paper maps. The PDA/PC/EC can be either stationary or mobile. The PDA/PC/EC permits generalized display of grid quadrangles of a constant scale grid system representing a specified geographical area and any of a selected group of latitude/longitude located objects. The geographical coordinate system located objects include user location, geographical destinations, and other selected geographical objects, from a set of databases stored in PDA/PC/EC memory devices or accessible through wired and wireless data communications links. The geographical objects are displayed on one or more generalized grid quadrangles or tiles of the grid system.

Brief Summary Paragraph Right (4):
The grid quadrangles coincide in geographical area with respective printed maps or grid quadrangles overlying the printed maps for correlation of location of geographical objects on the displayed grid quadrangle and corresponding printed map. For example the locations of displayed geographical objects on a user readable transitory computer display are correlated with surface features or mappable features depicted on the corresponding user readable printed map using the grid system. The same constant scale grid systems overlie and coordinate all the diverse media presentations of the same geographical areas. The databases of locatable objects and related information may include for example restaurants, hotels/motels, cities, municipalities, settlements, routes, transportation services such as airports and ferries, parks, recreation areas, campgrounds, hospitals, zoos, museums, tourist and sightseeing attractions, and other geographical landmarks or objects for user selectivity.

Brief Summary Paragraph Right (5):
The CAMLS is also applicable for use with radio location systems, dead reckoning location systems, and hybrid location systems. For example, the GPS satellite system is used with a GPS receiver for displaying location, travel direction, speed, route, and other traveling data of the CAMLS user on the generalized grid quadrangles for correlation of location with surface features or mappable features on the set of printed maps coinciding with the grid quadrangles. Multiple sets of maps and grid systems at different scales may be interrelated in the CAMLS. The CAMLS system provides "intelligent" printed maps by direct computer output of computed mapping and travel location data on grid quadrangles for correlation with mapped surface features on the corresponding printed maps. This can be accomplished by human senses, e.g. visually and intuitively between human readable forms of the map without the necessity of mentally or quantitatively determining latitude and longitude and without requiring any mathematical calculations by the user. Text and voice or audio outputs can be provided to facilitate use and reading of the printed maps. The invention also adds a communications dimension to the maps for adding and updating the latest spatially related data, for providing software tools for map analysis and reading, and generally for communications between computer systems and between users in a variety of combinations.

Brief Summary Paragraph Right (6):
A hand held personal GPS navigation tool has been developed by Trimble Navigation of Austin, Tex. 78759 under the trademark Scout GPS (TM). The Trimble navigation tool incorporates a GPS receiver and a four line character display for displaying position information in alphanumeric characters. It is stated that this hand held GPS system can display alphanumeric position information in a latitude/longitude coordinate system or a Universal Transverse Mercator (UTM) coordinate system. The Trimble navigation tool can apparently also display proprietary coordinate system information for locating the position of a user on a standard topographic map. The Trimble GPS navigation tool displays in alphanumeric characters the horizontal and vertical coordinate distances of the user from the southeast corner or southeast reference

point of any standard topographic map.

Brief Summary Paragraph Right (7):
A disadvantage of the Trimble GPS navigation tool is that it provides a display of coordinate system data only in alphanumeric characters on a multiline LCD display. The user must then perform mathematical measurements and operations to determine the user location on a particular topographic map. While the incorporation of GPS technology provides an improvement over dead reckoning and position estimation from topography, it necessarily requires user reference to quantitative measurements and calculations. Furthermore, the Trimble navigation device does not provide communications access to other geographical information databases for updated information on geographical objects in the spatial area of interest or communications access to other software tools for map analysis and reading. More generally, the Trimble navigation device does not provide a communications dimension for the map reading system.

Brief Summary Paragraph Right (8):
Silva Sweden AB and Rockwell International USA have developed a hand held GPS compass navigator for use on any standard map. The GPS compass navigator incorporates a GPS receiver for locating the user on any standard map. A built in "compass" gives range and bearing from the known user position to a specified destination. This information is updated on the GPS compass navigator as the user progresses toward the destination. The GPS compass navigator is described as being in the form of a guiding "puck" that apparently rides or is moved over the standard map at the user location. It therefore cannot display multiple geographical objects at the same time and cannot communicate with other sources of spatially related map information.

Brief Summary Paragraph Right (9):
Thomas Bros. Maps of Irvine, Calif. 92714 has developed a new "Page and Grid" (TM) identification system to locate streets, cities, communities or points of interest on a set of maps. Objects of interest are located by page number and grid name on the Thomas Bros. maps. Trip Builder (TM) products described in U.S. Pat. No. 4,998,752 use transparent map overlays for travel planning. However there is no electronic computer component to the "Page and Grid" (TM) system of Thomas Bros. or the Trip Builder (TM) transparent overlay maps to add an intelligent dimension for computer aided correlation, coordination, and communication.

Brief Summary Paragraph Right (10):
DeLorme Mapping Company of Freeport, Maine provides a self contained electronic map and navigation device under the trademark "MapKit". A CDROM stores a database of maps for display on a portable computer for assistance in routing, navigation, etc. The "MapKit" (TM) electronic map device is intended for self contained use and does not include a system specifically designed for correlation with human readable maps in other media such as printed maps.

Brief Summary Paragraph Right (11):
With respect to the abundance of paper maps and paper map series currently available, a user generally picks up a paper map with the questions in mind, "Where am I?", "Where is my proposed destination?", and "How do I get there?". The paper map alone is unable to answer these questions in a direct sensory, visual, and intuitive manner without map reading capability and some deductive reading and calculation by the user. There is no direct visual indication as, for example might be available on an electronic map of the surface features or mappable features of the same geographic area highlighting current location, proposed destination, and even a proposed route.

Brief Summary Paragraph Right (12):
It is an object of the present invention to provide a new multimedia system for correlation and coordination of spatially related information between diverse media such as transitory digital electronic displays or other computer outputs and graphics, text, fixed media presentations such as printed sheet media including printed maps. A related object of the invention is to provide communications of spatially related data between computer systems and between users in various combinations. Such a communications dimension permits for example updating with latest mapping and geographical object information and providing additional software tools for map reading and analysis.

Brief Summary Paragraph Right (14):
A feature and advantage of the novel constant scale grid system according to the invention is that the grid system enables visual, intuitive or other sensory correlation and coordination of spatially related location data. The grid system permits map reading without requiring quantitative determination, analysis, or reasoning and without requiring mathematical calculations by the user.

Brief Summary Paragraph Right (15):
It is another object of the present invention to provide a computer aided map location system (CAMLS) based on coordination between a PDA or other digital or electronic computer (EC) such as a digital microprocessor based (PC), workstation, or mainframe digital computer, and a set of printed maps typically printed on paper, depicting surface features at desired levels of detail. A feature of this coacting system is particularly useful for embodiments of the invention using hand held devices, small portable and mobile computers, and field applications where available and affordable memory modules may be limited. The massive digital electronic database necessary for depicting surface features in sufficient detail on electronic maps is not required because the full map database is effectively stored and available on paper or other sheet media. In other applications, the electronic map and display can provide greater detail than the printed map, updating and supplementing the printed map, and even printing a new map.

Brief Summary Paragraph Right (16):
The CAMLS system of the invention adds a computer dimension to the printed maps and is therefore intended to provide intelligent printed maps. The computer correlates, coordinates, and communicates information in a common geographical coordinate system such as the latitude/longitude coordinate system. An object of the invention is to provide direct visual display of intelligent map location information on grid quadrangles of a PDA/PC/EC display for correlation with printed maps depicting geographical areas coinciding with the geographical areas of the grid quadrangles. Coordination and correlation of spatially related data by the user is accomplished intuitively without requiring the user to make any latitude and longitude measurements or UTM determinations or any mathematical calculations whatever.

Brief Summary Paragraph Right (17):
Another object of the invention is to display on the PDA/PC/EC, geographical coordinate system located objects or other selected geographical objects from other databases with reference to a generalized grid quadrangle also located by latitude and longitude or other geographical coordinate system. The grid quadrangle in turn coincides in geographical area with a detailed map of a set of maps or a grid quadrangle overlay on the map, typically printed on paper for correlation of location of geographical objects on the displayed grid quadrangle and corresponding printed map. For example, the locations of displayed latitude and longitude located objects in a grid quadrangle are correlated with surface features depicted at desired levels of detail on the corresponding printed map for the same geographical area. An advantage of the present invention is that objects are located by the user on one of the detailed printed maps by direct sensory, visual, and intuitive comparison with the PDA/PC/EC display.

Brief Summary Paragraph Right (18):
A related object of the invention is to provide printed maps and other "fixed" media maps with a communications dimension for updating maps and associated geographical objects with latest geographically related information. The invention provides communications access to a variety of database sources of updated information on latitude/longitude locatable objects. The database sources can be internal or external, local or remote, using memory devices and diverse communications links to multiple database sources and service centers. The communications dimension of the present invention can also make available software tools for map reading and analysis over communications links.

Brief Summary Paragraph Right (19):
A further object of the invention is to provide a CAMLS for use with radio location systems, dead reckoning location systems, and hybrid location systems for displaying user location. For example, the GPS satellite system is used for displaying the location, direction of travel, route, speed, and other travel data of a CAMLS user on

a generalized grid quadrangle for correlation of user location on a coinciding printed map. All this is accomplished by direct sensory, visual, and intuitive methods.

Brief Summary Paragraph Right (20):
The CAMLS system is intended to provide alternative and multiple levels of detail with alternative and multiple scales of displayed grids, grid quadrangles and corresponding printed maps, and with alternative and multiple databases both internal and external, local and remote, for display of selected geographical objects and spatially related information according to the requirements of the CAMLS user. The invention is intended to provide display of generalized grid quadrangles on a PDA/PC/EC display correlated with selected geographic areas and with selected levels of background context and detail according to the memory capability of the PDA/PC/EC and the communications links and communications services coupling the CAMLS user to other CAMLS systems, external data bases and service centers. The selected levels of background context and detail may vary according to the memory devices or modules available for user requirements, according to wired or wireless on line information services available, according to internal and external databases available, and according to user choice.

Brief Summary Paragraph Right (21):
In the simplest embodiments, there is no graphic display at all, and uniquely named grid quadrangles, in response to location queries, are identified by text/alphanumeric line displays, audio/voice outputs, or other types of computer outputs. At the next level of detail/background, the grid quadrangle boundaries alone are displayed on the computer display for containing and indicating generalized location of latitude/longitude or other geographical coordinate system locatable objects for correlation of location on a corresponding printed map. The edges of a display screen itself may function as the grid quadrangle boundaries or the grid lines forming grid quadrangle boundaries may be drawn and displayed on the screen inside the edges of the display screen. Multiple grid quadrangles may also be displayed on the display screen. In a radio location, dead reckoning location, or other user location system such as the GPS embodiment, user location, direction of travel, and other travel data are also displayed on the selected grid quadrangle.

Brief Summary Paragraph Right (22):
In embodiments with greater memory capacity, multiple memory device capability affording access to selected internal databases, or wired or wireless on line communication access to external databases, additional software tools for map interpretation, and other spatially related information, the grid boundaries may be displayed with selected background features and landmarks of the correlated geographic area for further sensory, visual, or intuitive orientation by the user. Furthermore, latitude/longitude or other geographical coordinate locatable objects selected for display may be displayed with major routes or street locations or other geographical landmarks adding visual cues for rapid visual correlation and location on the corresponding printed maps. Similarly, the user location, route, speed, and direction of travel determined by a radio location system, dead reckoning location system, or hybrid location system may also be displayed with greater or lesser background context and detail of selected routes and landmarks or other geographical landmarks to facilitate visual correlation of the display with printed maps.

Brief Summary Paragraph Right (23):
The invention is intended to provide a computer aided map location system in which the user can fill the screen of the PDA/PC/EC display to whatever level of selectivity the user requires. For example a municipal planner might display a database of local fire hydrants, residential housing information, or GPS positioning of particular selected objects on the selected grid quadrangle or quadrangles. This may be shown for example, in association with the street layout or other infrastructure layout of the municipality. Memory modules can be made available to supplement displays on the PDA/PC/EC display with a variety of alternate internal databases. In the case of a desktop computer workstation, PC, or mainframe with essentially unlimited hard disk drive capacity, the user can display on the PC/EC screen whatever level of background context and detail is required or desired to supplement the display of geographical coordinate located objects. Alternative external databases are also available through wired and wireless data communication links with other CAMLS systems and users, external databases and software tools, and service bureaus, affording the user further selectivity and modularity in choosing levels of background context and detail.

Brief Summary Paragraph Right (24):
On the other hand, in the simplest PDA, the screen itself is used to define the boundaries of a grid quadrangle and the screen boundaries may be molded with "hash marks" or grid subdivisions for more detailed geographical location. In a full PC/EC desktop system or workstation, multiple grid quadrangles may be displayed, e.g. 16 grid quadrangles with display of selected levels of detail. Multiple grid quadrangles may also be displayed on the simplified PDA embodiment accompanied by simplified background commensurate with a lesser level of detail. The system components can be modular, with regular addition of new and different internal databases through updated memory modules and devices and external databases through wired and wireless data communications links to other CAMLS systems and users, external databases and software tools, and communication service centers. Any desired level of information can be displayed in association with the correlated printed maps depicting surface features in greater or lesser amounts of detail.

Brief Summary Paragraph Right (25):
The selectivity and modularity of the CAMLS system are important features of the invention permitting implementation of the invention from the simplest PDA's to effective desktop PC/EC systems workstations, and mainframes. The invention permits the CAMLS user to display on a displayed grid quadrangle whatever subject matter and level of detail are deemed appropriate for the user requirements and to access whatever spatially related data may be required.

Brief Summary Paragraph Right (26):
The system can be programmed with greater or lesser degrees of database content, software tools for map reading, interpretation, analysis, and expansion, and display logic for correlation with the generally more detailed printed paper or other sheet media maps. In either case the CAMLS system can facilitate user selection of the correct uniquely named grid quadrangle so that it is correlated with the correct printed map. The varying levels of detail from selected database modules, memory devices, and data communication links can be displayed on the generalized grid quadrangles for correlation with the generally more detailed surface features or mapping features depicted on the corresponding printed paper or other fixed media maps. The end result may be printed maps, trip tickets, and itineraries printed by the PDA/PC/EC printer for a variety of traveling and data collecting and selective display purposes. A variety of supplemental and updating information for any required spatially related data about geographical objects, etc., can be made available on modular memory devices such as PCM/CIA cards, CD ROMS, diskettes, etc. and over wired and wireless broadcasting and telecommunications data communications links and networks.

Brief Summary Paragraph Right (28):
In order to accomplish these results, the invention provides in the preferred examples a computer aided map location system (CAMLS) having at least one printed map corresponding to a selected geographical area. The printed map depicts surface features or mappable features at a desired level of detail. The printed map incorporates grid lines which, in the preferred example, are substantially parallel with lines of latitude and longitude. Other geographical coordinate systems may also be used. The grid lines define boundary lines of grid quadrangles or grid tiles identified by unique names.

Brief Summary Paragraph Right (29):
A personal digital assistant, portable personal computer, or other digital or electronic computer (PDA/PC/EC) provides a display or other computer output. The PDA/PC/EC can be either mobile or stationary and is programmed to display an image of at least one selected grid quadrangle identified by unique name by displaying the boundary lines of the grid quadrangle for correlation with a corresponding grid quadrangle of a printed map. The unique gridname is also displayed for selection of the correct similarly named corresponding printed map. In one embodiment of the invention, the edges of the screen display themselves form the boundary lines of the selected grid quadrangle and the screen edges can be formed with hash marks or grid subdivisions to facilitate location within the selected grid quadrangle.

Brief Summary Paragraph Right (30):

The PDA/PC/EC incorporates or provides access to at least one database of selected latitude/longitude locatable objects (loc/objects) identified in the preferred example by latitude and longitude location. The PDA/PC/EC is programmed to display the location of selected loc/objects in a grid quadrangle for user correlation of locations on the grid display with locations on the printed map. For example, the user can make this correlation and coordinate locations using surface features or mappable features depicted on a corresponding grid quadrangle of the printed map.

Brief Summary Paragraph Right (31):
Alternatively or in addition, a radio location receiver such as a GPS receiver is coupled to the PDA/PC/EC. The PDA/PC/EC is programmed to display the location of a user based on signals from the GPS receiver or other radio location receiver in a selected grid quadrangle image. A full screen can be constituted to be the selected grid quadrangle. Or, multiple grid quadrangles may be displayed. The user correlates and coordinates locations on the grid quadrangle computer display with locations on a corresponding grid quadrangle of a printed map. Additional travel data can also be displayed including user direction of travel, velocity, altitude, and route traveled, all derived from the GPS receiver or other radio location receiver. In addition to radio location, other user location systems may also be incorporated into the CAMLS such as dead reckoning location systems that measure user location from a known origin. Hybrid location systems are also available combining radio location and dead reckoning.

Brief Summary Paragraph Right (32):
The CAMLS user can be provided with communications links for on line communication and transfer of spatially related data and software tools for map reading between computers and between users. For example a CAMLS user may communicate with another CAMLS system or user for transfer of user location data and any other spatially related data. The CAMLS user can communicate with external data bases, a central communications service bureau, and on line mapping services for latest information relating to loc/objects, routes, and map modifications, priority messages, etc.

Brief Summary Paragraph Right (33):
In the preferred example embodiments, the invention provides a computer aided map location system (CAMLS) with a first set of substantially constant scale printed maps at a first scale depicting surface features over a specified geographical area. The printed maps of the first set of printed maps substantially coincide, in geographic area depicted, with substantially equal area grid quadrangles of a first scale grid. The first set of maps may constitute, for example, a national atlas for a selected country, dividing the country into constant scale regional grids at a regional scale with a detailed printed map for each region. The first scale grid tiles are identified by a first set of unique names. The CAMLS PDA/PC/EC has a display and memory device incorporating a first database and a mapping display subsystem performing functions of a database manager, controlling the presentation of mapping data. The first database includes the first set of unique names of the grid quadrangles of the first scale grid.

Brief Summary Paragraph Right (35):
According to the invention the mapping display subsystem is constructed to cause the drawing and display of a selected grid quadrangle of the first scale grid identified by its unique name by displaying on the PDA/PC/EC display the boundary lines of the selected grid quadrangle. Alternatively, the edges of the screen display function as the boundary lines of the selected grid quadrangle and the selected grid quadrangle fills the display screen. The grid quadrangle unique name is displayed on an alphanumeric digital display such as a single line or multiline display. The grid quadrangle is correlated by the user with a printed map from the first set of printed maps coinciding with the uniquely named selected grid quadrangle.

Brief Summary Paragraph Right (36):
In various embodiments of the invention the selected grid quadrangles are displayed with different amounts of detail associated with the displayed grid quadrangle according to available memory capacity, available modular and replaceable memory devices providing internal databases, available wired and wireless data communications links to external databases, communications with other CAMLS systems and users, communications service centers, according to user choice. According to one embodiment,

the boundaries of the grid quadrangle alone are displayed bounding a selected geographic area or the full screen is constituted as the grid quadrangle for correlation of locations on a corresponding printed paper map. With greater memory capacity achieved for example with add on memory devices or modules, or external data communications links, the grid quadrangle may be displayed with additional visual context such as selected major routes, cities, or landmarks in the geographical area of the grid quadrangle.

Brief Summary Paragraph Right (37):
Such greater or lesser visual context can be used to facilitate visual orientation by the user and to facilitate visual and intuitive cross reference, correlation, and coordination of a location on the computer display with a location on the corresponding printed map, for example using surface features provided generally in greater detail on the corresponding printed map. The modularity of the system with a variety of internal memory device modules or external data communications and telecommunications links affords greater selectivity to the user in deciding what subject matter features and what level of detail to portray on the screen display of the PDA/PC/EC. The various embodiments with different levels of detail are available in the different versions of the invention as hereafter described.

Brief Summary Paragraph Right (38):
Thus, the invention contemplates presentation of two human readable or user readable maps for user cross reference, correlation, coordination, and communication. One map, the printed map, is fixed in a relatively permanent medium and taken alone is "dumb" and is not readily changeable. The other map, a digital computer electronic map, is presented on a transitory computer display, is readily changeable, and "intelligent", adding an intelligent dimension to the relatively permanent printed map. The two map presentations are correlated intuitively by the user using the novel grid system of uniquely named grid quadrangles which overlie the two coordinated maps.

Brief Summary Paragraph Right (39):
The memory device or devices of the PDA/PC/EC or external data communications links also provide a second database of latitude and longitude locatable objects (loc/objects) identified by the computer in the second database by latitude and longitude location in the specified geographical area. The display subsystem is constructed to cause selected loc/objects to be displayed in the selected grid quadrangle of the first scale grid. The displayed loc/objects can thereby be correlated by the user with locations on the corresponding printed map of the first set of printed maps coinciding in geographic area with the specified grid quadrangle. While the standard latitude and longitude coordinate system is the preferred coordinate system for automated computer location of the loc/objects, other geographical coordinate systems such as UTM may also be used.

Brief Summary Paragraph Right (40):
In various embodiments of the invention, the second database of latitude/longitude located objects (that is objects identified by the computer in the second database by latitude and longitude coordinate location and referred to herein as loc/objects) may incorporate different amounts of detail associated with the loc/objects for display on the PDA/PC/EC. According to one embodiment, the location of a loc/object alone is displayed on a grid quadrangle presented on the CAMLS PDA/PC/EC display for correlation and coordination of that location with a corresponding location on a printed paper map. With greater memory capability, additional or alternative memory devices, or external data communications links, the loc/object may be associated with additional visual cues such as major routes, street location, cities, or other geographical landmarks in the grid quadrangle to facilitate sensory, visual, and intuitive orientation and visual correlation by the user with the printed paper map. This can be accomplished with replaceable modular memory devices storing a variety of databases suitable for use with the selected hardware or through data communications links to external databases, information service bureaus, other CAMLS systems and users, etc. For example PCM cards may be used with the PDA while diskettes, CDROMS and similar devices may be used with portable and desktop PC's and workstations. The user can then more easily associate the loc/object with for example, surface features or mapping features generally depicted in greater detail on the corresponding paper map. The various embodiments with different levels of detail are presented in different versions of the invention as hereafter described e.g. with or without location of the

user position, velocity, route, etc.

Brief Summary Paragraph Right (41):
An advantage of the computer aided map location system is that a massive digital electronic database necessary for depicting surface features or mappable features in sufficient detail for full electronic maps is not required. The detailed map database is effectively stored and available on the printed maps. This advantage of the CAMLS system is particularly applicable for hand held device and smaller portable, mobile, and field computers with limited or expensive memory. In other applications the electronic map may provide greater mapping information than the printed map.

Brief Summary Paragraph Right (42):
The second database of latitude and longitude or other geographical coordinate loc/objects is provided by relatively smaller specialized databases or database modules such as selected restaurants, hotels/motels, cities, municipalities, settlements, routes, transportation services such as airports and ferries, parks, recreation areas, campgrounds, hospitals, zoos, museums, tourist and sightseeing attractions and other selected geographical objects and landmarks in the specified geographical area. For example the second database of loc/objects may also incorporate recommended routes between selected loc/objects for display on corresponding grid quadrangles for correlation with surface features of a printed map of the first set of maps coinciding with the selected grid quadrangle. Routing software and routing algorithms may also be used.

Brief Summary Paragraph Right (43):
The internal databases can be stored on memory devices such as replaceable PCM cards or PCMCIA cards for use in association with the PDA/PC. The PCM cards can be regularly upgraded and updated with latest information. For portable and desktop PC's and workstations, diskettes, CDROMS, and other appropriate memory devices are used for the database memory modules. External databases are also made available through wired or wireless data communications links. The communications dimension provides access not only to effectively unlimited external data bases, but also additional software tools for mapping and map reading use, exchange of information with other CAMLS users, communications service bureaus, etc.

Brief Summary Paragraph Right (44):
The invention also provides a first set of printed maps having a second scale grid formed on the maps of the first set. The second scale grid subdivides each of the grid quadrangles of the first scale grid into a plurality of substantially equal area second scale grid quadrangles. The second scale grid quadrangles are identified by a second set of respective unique names. The second scale grid is also formed by grid lines defining the boundary lines of the second set of grid quadrangles. The boundary lines of the second scale grid quadrangles are, in the preferred embodiment, substantially parallel to lines of latitude and longitude across the specified geographic area. Other geographical coordinate systems may of course consistently be used.

Brief Summary Paragraph Right (45):
According to the invention the database manager is constructed for drawing and displaying on the PDA/PC/EC display the boundary lines of a selected grid quadrangle of the second scale grid identified by unique name. Alternatively, the selected grid quadrangle of the second scale grid is expanded to fill the screen display so that the edges of the screen constitute the boundaries of the selected grid quadrangle. The database manager also displays selected loc/objects of the second database on the grid quadrangles of the second scale grid presented on the CAMLS PDA/PC/EC display for coordinating and correlating locations on the computer display with locations on corresponding printed maps. Surface features and mapping features on a printed map of the first set of printed maps can assist finding locations.

Brief Summary Paragraph Right (46):
In the preferred example embodiment the CAMLS incorporates a second set of substantially constant scale printed maps at the second scale depicting surface features or mappable features in greater detail than the first set of maps over the specified geographical area. The printed maps of the second set of printed maps substantially coincide, in geographic area depicted, with grid quadrangles of the

second scale grid. The second set of printed maps may constitute, for example, a regional atlas for a selected region of the country dividing the region into constant scale subregional grid quadrangles at a subregional or state scale with a detailed printed map for each subregion or state. Selected loc/objects are displayed on a second scale grid quadrangle on the PDA/PC/EC display screen for correlation of locations indicated on the CAMLS computer display with corresponding locations on the respective printed map, for example using surface features or mapping features depicted at desired levels of detail on the coinciding printed map of the second set of printed maps.

Brief Summary Paragraph Right (47):
As in the first scale grid, the second scale grid quadrangles and loc/objects of the second database may be stored and displayed in different embodiments with different levels of detail according to the available memory capability, available memory devices and modules, and available external data communications links. Greater levels of detail provide additional visual framework to facilitate user orientation and visual or other sensory correlation and coordination between the grid display and the corresponding paper map. The modularity of the CAMLS system again affords greater selectively to the user in deciding what level of detail of visual or other sensory cues and context and what content and subject matter to provide. Additional geographic detail may be stored for example in memory devices such as PCMCIA cards for use with the PDA, diskettes and CDROMS for portable PC's, desktop PC's, and workstations, or be made available via data communications links from external databases, communications service centers, other CAMLS systems and users, etc.

Brief Summary Paragraph Right (48):
The second set of maps may also include a third scale grid formed on the maps of the second set. The third scale grid subdivides each of the grid quadrangles of the second scale grid into a plurality of substantially equal area third scale grid quadrangles. The third scale grid quadrangles are also identified by a third set of unique names in the first database. The third scale grid quadrangles are, in the preferred example, also defined by boundary lines identified internally by the computer using the latitude and longitude coordinate system or other consistent geographical coordinate system in the first database. As in the first and second scale grids, the third scale grid quadrangles and loc/objects from the second database may be stored and displayed in the various embodiments with different levels of detail according to the available memory capacity, memory device capability, or data communications links, to facilitate user orientation. Additional scale grids and component grid quadrangles can also be provided for displaying and correlating further levels of detail by the CAMLS.

Brief Summary Paragraph Right (49):
In the preferred example embodiment, the CAMLS incorporates a third set of substantially constant scale printed maps at the third scale. The printed maps of the third set of printed maps cover smaller geographic areas than either the first or second sets of maps and depict surface features or mappable features in greater detail than the first and second sets of maps. The printed maps of the third set of printed maps substantially coincide in geographic area depicted, with grid quadrangles of the third scale grid. The third set of printed maps may constitute, for example, a metro atlas for the selected country, or selected region of the country, or selected subregion or state, dividing selected metropolitan areas of subregions into substantially constant scale metropolitan grids at a metropolitan scale with a detailed printed map for each metropolitan area.

Brief Summary Paragraph Right (50):
According to another preferred embodiment of the invention, the PDA/PC/EC is provided with a radio location receiver such as a loran receiver or a GPS receiver for generating signals corresponding to the geographical coordinate location and direction of travel of a CAMLS user. Dead reckoning location systems and hybrid location systems may also be used. The database manager is constructed for displaying on the PDA/PC/EC display the location, direction of travel, speed and traveling route of the CAMLS user on a selected grid quadrangle displayed on the PDA/PC/EC display. The displayed location and route can be correlated with locations on the printed map coinciding in geographic area with the selected grid quadrangle. The GPS CAMLS can be used in a separate and independent CAMLS system without any databases of loc/objects as a stand alone system or in combination with the second database and other available internal

and external databases for display of selected loc/objects from such databases. The CAMLS systems and users can exchange data for display or other use such as user location information as well as other spatially related data. This is accomplished over a variety of communications links, wired or wireless, adding a communications dimension to the CAMLS.

Brief Summary Paragraph Right (51):
In the various embodiments of the invention, the radio location data such as GPS data processed by the receiver may be displayed in a variety of formats conveying lesser or greater amounts of information according to the memory capacity, available replaceable memory devices or modules, on line wired or wireless data links to external databases, information bureaus, other CAML systems and users, etc. In the simplest embodiment the user location may be pinpointed on a generalized grid quadrangle displayed on the PDA/PC/EC. In further embodiments the user location may be displayed by an arrow also indicating the direction of travel of the user. A "hole" or "circle" in the arrowhead is used to show current user location. User velocity may be indicated by the length of the arrow. User location, direction of travel, and velocity information is therefore recorded if the display is printed in hardcopy. The device can also trace and display the route of the user across the grid quadrangles displayed on the PDA/PC/EC.

Brief Summary Paragraph Right (52):
Furthermore, the user location may be associated with a street address location, major routes, cities, or other geographical landmarks in the vicinity of the user location also displayed on the grid. Such additional visual or other sensory information can be made available on memory devices such as PCMCIA cards used in association with a PDA, other memory devices for PC/EC's, and over data communication links to external databases, information bureaus, and other CAMLS systems and users. This additional information associated with the user location can facilitate user map orientation and correlation of the user location, direction of travel, and route, with a location on the corresponding printed map for example, using surface features depicted at desired levels of detail on the corresponding printed paper map. This capability provides greater user selectivity in determining what level of detail and what content and subject matter to display.

Brief Summary Paragraph Right (53):
According to another aspect of the invention, the grid quadrangles or tiles for the same scale or level and grid quadrangles or tiles at different scales or levels can be related to each other by a database manager of the PDA/PC/EC in a manner similar to the "space ship" algorithm set forth in the David M. Delorme U.S. Pat. No. 4,972,319 issued in 1990 for "Electronic Global Map Generating System" and the David M. DeLorme U.S. Pat. No. 5,030,117 issued in 1991 for "Digital Global Map Generating System". According to the "space ship" algorithm, the CAMLS user can "scroll", "fly", or shift between different grid quadrangles, tiles or windows at the same scale or level and "zoom" between grid quadrangles, tiles, or windows at different scales or levels. The grid quadrangles, tiles or windows at different levels are organized in a "tree" data structure. In the preferred example set forth in U.S. Pat. 4,972,319 and 5,030,117 the grid quadrangles at different levels are related to each other in a quad-tree data structure although other tree data structures such as hex and octal may of course be used. The specifications of the two DeLorme Pat. Nos. 4,972,319 and 5,030,117 are incorporated herein by reference for further details of this example.

Brief Summary Paragraph Right (54):
An example of printed maps constructed in substantially equal area constant scale grid quadrangles can be found in the DeLorme Publishing Company Atlas and Gazetteer Series available for most of the states of the United States. The pages of the volumes from the Atlas and Gazeteer Series constitute the constant area and constant scale grid quadrangles for each volume.

Brief Summary Paragraph Right (55):
For example in The Maine Atlas and Gazetteer published by DeLorme Publishing Company, Freeport, Me., revised and updated annually, the printed map on each page represents a grid quadrangle at a scale of approximately one half inch equals one mile, that is one unit of distance on the printed map equals approximately 125,000 units of distance on the earth. This scale is maintained consistently for the grid quadrangle pages. The scale of each map is selected so that each grid quadrangle, that is each page, is

composed of twenty-five minutes each of latitude and longitude. Each map covers approximately twenty-nine miles of longitude or height on the earth's surface by twenty-one miles of latitude or width on the earth's surface. Lines of longitude running north and south eventually merge at the North Pole causing maps in the northern area to be narrower than those in the southern area of any particular Gazetteer. This format allows projection of the round earth on flat pages with minimum departure from the constant scale for all grid quadrangles.

Brief Summary Paragraph Right (56):
As exemplified in the DeLorme Publishing Company Atlas and Gazetteer Series the side boundaries of the grid quadrangles near the side edges of the pages are aligned with true north/south coinciding with lines of longitude. The top and bottom boundaries of the grid quadrangles near the top and bottom edges of the pages are aligned to run true east/west coinciding with lines of latitude. In reading the maps, adjustment is made for declination of magnetic north from true north when orienting the maps using a compass. Such constant scale grid quadrangle maps exemplified by the DeLorme Publishing Company Atlas and Gazetteer Series are contemplated for use as the printed maps or fixed media maps of the present invention. However, a national grid system can be provided so that the grid systems for each state match and are consistent with each other.

Brief Summary Paragraph Right (57):
According to an alternative embodiment of the invention, the digital electronic media aid for use with a corresponding printed map or maps need not take the form of a visual or graphic computer display. The coordination and correlation of spatially related data between a computer output and the more detailed fixed media representation of a geographic area may take the form of an alphanumeric or text computer output, an audio or voice computer output, or some combination of non-graphic display outputs. By way of example a PDA output in the form of an alphanumeric or text line output can identify location information or information spatially related to a location by naming or identifying the smallest grid quadrangle containing the subject location. Such a gridname may be, for example "US/NE/B2/A1/B1/A2". The smallest grid quadrangle at the highest resolution scale encompassing a pertinent geographical location can also be identified by an audio or synthesized voice output as well as or instead of an alphanumeric line output.

Brief Summary Paragraph Right (58):
It is not essential that the CAMLS user have the coordinated computer display and corresponding printed map at the same location. Thus, the invention contemplates "distributed" CAMLS systems. For example, a CAMLS computer and display equipped user may be at one location and a CAMLS printed map user be at another location joined by a communications link such as a telephone/FAX communications link. The CAMLS computer user can FAX an image of a grid quadrangle showing loc/object location for coordination and correlation of locations on the grid and printed map by the CAMLS printed map user. A simple display may improve the quality and lower the cost of the FAX transmission. Or, the CAMLS printed map user can FAX a corresponding image of the printed map to the CAMLS computer user. The result is a complete distributed CAMLS system with elements of the complete system at two locations. The communications link might also include voice telephony and mobile radio.

Brief Summary Paragraph Right (59):
As used in the specification and claims the phrases "computer display" and "display" are intended to include transitory visual displays such as graphic screen displays, alphanumeric or text line displays, and hard copy output displays. The phrases "computer outputs" and "outputs" are intended to be more general, however, encompassing not only computer displays, hard copy displays, and odometer style line displays or outputs, but also voice and sound outputs, other sensory outputs such tactile and braille outputs, and "virtual reality" outputs.

Brief Summary Paragraph Right (60):
Upon correlation and coordination of the uniquely named grid quadrangle with the corresponding printed map, additional information related to the selected grid quadrangle area can then be interrogated including selected information from any available internal and external databases using memory devices and on line communications services. Alternatively, input of particular queries about identified

restaurants, motels, ferry services, tourist attractions, and any geographical landmarks or objects of interest etc. can prompt a non-graphics text or alphanumeric response by the PDA or other digital computer identifying the location within the smallest uniquely named grid quadrangle. The response can be made in any available or appropriate computer output including voice/audio outputs alone or supplementing other computer outputs including computer screen displays, line displays, and hard copy outputs. Reference can be made to the corresponding printed map and additional spatially related information can be queried from databases relevant to the selected grid quadrangle.

Brief Summary Paragraph Right (61):
According to various alternatives, the electronic media computer output may take the form of text or alphanumeric indicia only, voice output only, and voice and text outputs in combination. Furthermore the invention contemplates electronic computer media outputs in the form of visual graphic displays and map displays only and visual graphic computer displays in combination with either text and alphanumeric indicia or voice/audio output or both.

Brief Summary Paragraph Right (62):
As used in the specification and claims, the phrase "printed map" is intended to cover all human readable fixed media representations of a geographic area or map such as printed maps printed on paper, Mylar (TM), as well as other "sheet media". The term "printed map" is also intended to encompass photographs, photographic images including positives, negatives, slides, microfilm, and microfiche that can be rendered in a human readable format. The phrase "printed map" is used herein and in the claims to cover video maps and video films, facsimile reproductions or faxes, and other fixed or developed media. The phrase "printed map" also encompasses projections of map images from all of the foregoing fixed media and other optical transformations. Such "printed maps" in fixed media may also take the form of three dimensional relief cartography, maps on deformable media such as rubber sheets, globes, and other three dimensional map presentations. Thus, printed maps also includes enlarged wallpaper maps and murals, paper wall maps or other enlarged maps such as backlighted wall maps and desk maps mounted over grids of lights controlled by the computer to illuminate the active grid areas or grid quadrangles of interest. The phrase "printed map" is used in the specification and claims to encompass all fixed media presentation of mapping analog imagery in two and three dimensions in human readable form including projections from the fixed media presentations and generally media which can present a map in user readable form.

Brief Summary Paragraph Right (63):
The word "fixed" is used in its broadest sense including the expansive meaning under the U.S. Copyright Laws encompassing all media in which a map or similar work may be embodied. Thus "fixed" encompasses not only "still" embodiments of maps and map related works but also animated maps, "movies", etc. and any fixed medium that presents a map in human readable form.

Brief Summary Paragraph Right (64):
As used in the specification and claims the phrase "locatable objects" or "loc/objects" is intended to encompass all objects either stationary or moving whose location can be identified in a selected geographical coordinate system related to the digital electronic media displays and outputs or the printed maps. The phrase "loc/objects" can encompass all stationary features either natural or man made associated with a selected grid quadrangle. Thus "loc/objects" can encompass any selected natural features of the landscape or any human constructed objects or structures of interest to the user including the list of objects of interest to travellers set forth above. With respect to moving objects, the "loc/objects" can include the travelling user location, location of any selected vehicles such as, for example, a fleet of vehicles used in a business, vehicles in the air, on land and in the sea and any other moving objects of human or natural origin that can be localized in space and time and whose locus may be of interest to the user. Moving objects may also encompass natural phenomena such as tides, currents, sediment transport, lava flow, tectonic plates, animal migrations and any aerial, terrestrial, marine or submarine movements which can be identified and may be of interest or the subject of study.

Brief Summary Paragraph Right (66):
The phrase "surface features" is generally used to identify fixed features of the surface of the earth which may be of natural origin or human origin for example hills, forests, rivers, lakes, swamps, and highways, roads, settlements, buildings and structures. More generally the phrase "surface features" is intended to encompass "mappable features" or "mapping features" and "mappable events" and "mapping events". Thus, "surfaces features" and "mapping features" refer to substantially localized features and events of natural and human origin which can be identified by location in a geographical coordinate system and assigned a location and symbolic representation on an electronic map or a printed map.

Brief Summary Paragraph Right (67):
The word "geocoding" in the CAMLS system is used to characterize the computer operation of assigning a location to an object. In the case of a geographical or latitude/longitude locatable object this constitutes in the preferred embodiment assigning a latitude and longitude coordinate location on the Earth's surface. The loc/object is also assigned a grid name for the unique grid including its location. The location assignment task commits the location to computer memory in the appropriate database and enables the mapping function of displaying a symbol at the appropriate location on displayed maps. A subsidiary function of geocoding is assigning a location for a non-geographical object such as a text message for the purpose of "located screen sharing". Geocoding assigns a display location on a map for purposes of screen sharing even though the text message has no real geographical location on the face of the earth.

Brief Summary Paragraph Right (68):
In the simpler hardware embodiments of the present invention it is generally contemplated that the fixed media presentation of a geographical area such as a printed map will depict surface features or mappable features in greater detail than the electronic media presentation such as a transitory computer display or output which adds an intelligent dimension to the printed map. However in more complex hardware embodiments, the electronic media presentation in the form of a digital computer display of an electronic map may in fact depict greater detail of surface features or mappable features than the fixed media printed map presentation. This situation may occur for example when the digital computer and its accompanying transitory display are used to update the printed map or are the source of a printed map from a multicolor printer or plotter coupled to the output of the digital computer. In this respect the present invention may provide the capacity for map making or map creation resulting in a derivative printed map having greater detail than an original printed map correlated with an original transitory display of a digital computer. The correlation of spatially related data according to the present invention is generally between a printed map with surface features and mapping features and a coordinated and correlated digital computer display or output adding an intelligent dimension. As noted above, the invention contemplates and encompasses situations in which the electronic media digital computer display may exhibit greater detail of surface features and mapping features than the coordinated and correlated fixed media presentation.

Brief Summary Paragraph Right (69):
By way of another example, a user by wired or wireless data communications link may access an external database or information service bureau that provides detailed information not available on the corresponding printed map. For example a service bureau might provide very detailed information on selected mappable topics of interest to the user resulting in a computer display of surface features or mappable features in greater detail than the original corresponding printed map. According to another example, an information service bureau might provide an updated map or updated data for constructing an updated map on the digital computer display. In this respect, the new map presented on electronic media may have greater detail of surface features or mapping features than the original corresponding printed map.

Brief Summary Paragraph Right (70):
While the description of the present invention is primarily directed to the applications of the invention for computer aided map reading, analysis and interpretation and for supplementing the maps with spatially related data from databases derived from memory devices and communications links, the invention is also

applicable for map making and map creation. Thus, the GPS CAMLS may communicate GPS location data from on-site geocoding to a home office for accumulation and assembly of mapping data. At the same time the invention can provide on-line mapping information services to other CAMLS systems and users.

Brief Summary Paragraph Right (71):
The invention contemplates a wide variety of computers and computer hardware configurations for incorporation in the CAMLS system. PDA/PC/EC as used herein is intended to cover computers that are portable, mobile, or stationary. The computers contemplated by the CAMLS system include in vehicle computers such as a dashboard, firewall, sun visor and rear view mirror computer mapping displays and associated computer processors. The CAMLS computers also include embedded computer technology applications where the computer is embedded in a non-computer apparatus without a computer style interface. For example, the GPS CAMLS invention is applied in an in-vehicle alarm system transmitting grid location and position data in the event of accident, theft, unauthorized entry. The response service uses the corresponding printed maps to reach the vehicle from a central dispatch location.

Drawing Description Paragraph Right (1):
FIG. 1 is a diagrammatic action view of the CAMLS system showing a user operating the computer aided map location system (CAMLS) including a set of printed paper maps, PDA/PC with screen graphics display, and an enlargement of the graphics display showing a grid quadrangle correlated with a corresponding grid quadrangle of a printed map depicting mapping features in greater detail.

Drawing Description Paragraph Right (2):
FIG. 1A is a detailed perspective view showing a snap on template while FIG. 1B shows "peel off" decals, for adding hash marks or grid quadrangle subdivision marks to the boundaries or edges of the PDA/PC screen display coinciding with similar subdivision marks on the printed maps.

Drawing Description Paragraph Right (3):
FIG. 1C is a detailed fragmentary plan view showing an alternate PDA display with cross hairlines to facilitate user location relative to the grid quadrangle subdivision marks.

Drawing Description Paragraph Right (4):
FIG. 1D is a detailed diagrammatic plan view of an arrow for presenting user travel information on a PDA/PC display.

Drawing Description Paragraph Right (5):
FIG. 2 is a diagrammatic action view of the CAMLS system with two GPS CAMLS embodiments and two CAMLS users in direct communication over a wireless communications link.

Drawing Description Paragraph Right (6):
FIG. 3 is a diagrammatic action view showing a user operating the CAMLS system with selected background context also presented on the PDA display to facilitate user correlation with mapping features depicted in greater detail on the printed map.

Drawing Description Paragraph Right (10):
FIG. 6 is another diagrammatic view of the CAMLS system with desktop PC or workstation programmed for printing strip maps or "trip tickets" showing proposed routes of travel from a point of origin to a destination.

Drawing Description Paragraph Right (15):
FIG. 11 is a generalized flow chart for the selection and display of grid quadrangles identified by unique grid quadrangle name or geocode.

Drawing Description Paragraph Right (17):
FIG. 13 is a diagrammatic perspective view partially exploded of another CAMLS in which the printed map is in the form of an enlarged backlighted wall map display for example for use at a command and control headquarters for tracking fleets of vehicles through a multi-grid area.

Drawing Description Paragraph Right (18):
FIG. 14A is a simplified diagrammatic view of an accident scene for a vehicle having a GPS CAMLS alarm system actuated by the accident impact to initiate wireless communication of emergency "geocoded" accident location data. FIG. 14B is a simplified diagrammatic view of the central dispatcher headquarters with a CAMLS system including the backlighted translucent wall map of FIG. 13, receiving the emergency communication and calling a tow truck. FIG. 14C is a simplified action view of the tow truck operation with a simplified CAMLS system checking the corresponding grid of the accident location on a printed map. FIG. 14D is a simplified action view of an alternative embodiment showing a CAMLS PDA user at the accident scene "geocoding" the accident scene location for transmission of position data to the central dispatch office. FIG. 14E is a simplified action view showing a CAMLS printed map user manually entering the accident location on the appropriate grid quadrangle of the printed map. FIG. 14F is a simplified diagrammatic view of a central headquarters location where the indicia marking the accident location on the printed map are scanned into the central computer database along with sufficient context from the corresponding grid quadrangle of the printed map.

Drawing Description Paragraph Right (19):
FIGS. 15A and 15B illustrate computer displays or hardcopy outputs for dialog box selections from the Loc/Object type submenu of TABLE VI, one of the submenus of the Display/Output Options main menu of TABLE V.

Drawing Description Paragraph Right (20):
FIGS. 15C, 15D, 15E and 15F illustrate computer displays or hardcopy outputs for dialog box selections from the GPS Display/Output submenu of TABLE VII, also one of the submenus of the Display/output Options main menu of TABLE V.

Drawing Description Paragraph Right (21):
FIG. 15G illustrates computer displays or hardcopy outputs for dialog box selections from the Sequences/Scripts submenu of TABLE VIII.

Detailed Description Paragraph Right (1):
A computer aided map location system 10 according to the present invention is illustrated by way of example in FIG. 1. A user 12 coordinates operation of the system 10 using an atlas 14 of printed paper maps and a personal digital assistant or PDA 15. According to one mode of operation of the system 10, the PDA 15 incorporates a GPS receiver. The user 12 may initiate operation of the system 10 by posing the query "Where am I?" with reference to the maps of the atlas 14. Based upon GPS data, the PDA responds by identifying the unique gridname or address US-NE-41-C3 for the grid quadrangle of a map where the user 12 is located. The gridname US-NE-41-C3 is displayed in an "odometer" style alphanumeric display 16, in this example below the graphics display 18 of the PDA. The unique gridname may alternatively be displayed directly on the graphics display 18.

Detailed Description Paragraph Right (3):
The PDA further responds by displaying on the graphics display 18 the grid quadrangle US-NE-41-C3 and a blinking dot 20 showing the location of user 12 in that grid quadrangle. The user 12, having turned to page 41 of the NE Regional Atlas 14, identifies the grid quadrangle C3, and then visually and intuitively determines his or her location with reference to detailed mapping surface features depicted on the paper map at page 41 by comparison with the blinking dot 20 on the PDA graphics display 18.

Detailed Description Paragraph Right (4):
It is noted that in FIG. 1, the grid quadrangle US-NE-41-C3 is displayed in the simplest form, essentially a blank grid quadrangle with no background or context except for the boundary lines of the grid quadrangle. The boundary lines of the selected grid quadrangle can actually be drawn and displayed on the graphics display 18 near the edges of the rectangular display window. Or, as in the example of FIG. 1, the edges of the graphics display window are used as the boundary lines of the grid quadrangle.

Detailed Description Paragraph Right (5):
As shown in the blow up or enlargement of the PDA graphics display 18 in FIG. 1, the boundary edges of the graphics display window 18 are formed with "hash marks" or

subdivision marks 22 which further subdivide the selected grid quadrangle C3 on page 41. These hash marks or subdivision marks are also reproduced on the printed maps (not visible in FIG. 1) to further assist the user 12 in visually and intuitively determining his or her location with reference to the detailed mapping features depicted on the printed map. The hash marks or subdivision marks can be provided by a snap on adapter 24 as shown in FIG. 1A, which fits over the PDA graphics display window or a set of decals or "peel off" indicia 25 as shown in FIG. 1B which can be applied around the display window. The adapter hash marks can also provide necessary adjustments for change in aspect ratio of grid quadrangles in southern latitudes of Mexico and northern latitudes of Canada.

Detailed Description Paragraph Right (6):
Referring to FIG. 1, the pages of the NE Regional Atlas themselves can be viewed as the first or highest level grid quadrangles of a first level grid that covers the selected country. The grid subdivisions of each page of the grid defining grid quadrangles such as C3 can be viewed as the second or intermediate level grid quadrangles of a second level grid. The hash marks or subdivision marks on the PDA graphics display window and also reproduced on the printed maps of, e.g., the NE Regional Atlas can be viewed as defining a set of third level or lowest level grid quadrangles of a third level grid. The first level grid of grid quadrangles of lowest resolution, the second level grid of grid quadrangles of intermediate resolution, and the third level grid of grid quadrangles of highest resolution can all be represented by paper maps of different series of the United States or other Country Atlas Series. Additional level grids with additional levels of resolution can also be provided.

Detailed Description Paragraph Right (7):
By way of example, a first set of printed maps can be provided in the format of a country atlas such as a United States Atlas in which the pages coincide in geographic area depicted with the first level grid quadrangles, each covering a region of the country such as the northeast region. A second set of paper maps can be provided in the format of regional atlases such as the NE Regional Atlas 14 in which the pages coincide in depicted geographic area with the second level grid quadrangles. An additional or optional set of paper maps can be provided in the format of subregional atlases in which the pages coincide with the grid quadrangles such as the C3 grid quadrangles shown at Page 41 of the NE Regional Atlas of FIG. 1. The additional set of paper maps depict surface features in greater detail and with greater resolution than either the first or second set of maps. A third set of paper maps can be provided in the format of, for example, metropolitan or metro atlases in which the pages coincide in geographic area represented, with the third level grid quadrangles defined, e.g., by the hash marks or subdivision marks within the second level grid quadrangles. The third set of printed paper maps covering smaller geographic areas than the first or second sets of printed maps depict surface features in even greater detail, for example showing all streets of an urban or suburban metro area.

Detailed Description Paragraph Right (8):
Furthermore, the PDA or other digital computer (EC) such as a personal computer (PC) can be programmed to shift between grid quadrangles at the same grid level and zoom between the grid levels and present grid quadrangles at any selected level filling the graphics display screen. Each grid quadrangle at each level is identified by a unique identification code, name, or address similar to US-NE-41-C3 for presentation on the graphics display. As hereafter described, the user can select the desired grid level of detail or resolution of a printed map and display a corresponding grid quadrangle on the PDA or other PC.

Detailed Description Paragraph Right (10):
The simplified CAMLS system set forth in FIG. 1 requires minimal electronic memory to bring to life the paper maps and add an interactive dimension. An initial database is required identifying all the unique ID codes of the respective grid quadrangles along with the geographical coordinate location of grid boundary lines. A database manager and drawing algorithm presents each grid quadrangle as required by user queries or inputs and by GPS data and GPS data processing algorithms.

Detailed Description Paragraph Right (11):
The invention provides additional levels of display background detail and context to facilitate user correlation between the PDA/PC/EC screen graphics display and the

printed paper maps. For example, as shown in FIG. 1C, the blinking dot 28 showing user location based on GPS data can be accompanied by cross hairlines 30 to correlate the user location with subdivision lines at the border of the screen display or grid quadrangle boundary lines for correlation with similar marks printed on the paper maps. Additional GPS travel data can be imparted using an arrow 32 instead of a blinking dot to show the direction of travel of the user as shown in FIG. 1D. Exact user location can be shown by a "hole" or circle 34 in the arrow head, and the length of the arrow can be correlated with speed. The previous path of travel can also be shown in a track on the display.

Detailed Description Paragraph Right (12):
A variation on the CAMLS system of FIG. 1 is illustrated in the system 10a of FIG. 2. According to system 10a two PDA's 15,15a are provided with GPS receiver capability for two users 12,12a. The two PDA's are also linked to each other by cellular or wireless modems for direct communication of each other's position. Each PDA is programmed to display a "me" position blinking dot 20 and a "you" position blinking dot 21. In this case each PDA is displaying on its respective graphics display, a higher level grid quadrangle corresponding to the entire page 21 of the NE Regional Atlas showing the respective locations of the two users 12,12a on the same grid quadrangle. The two users can then correlate respective positions with surface features depicted in detail on the page 21 printed paper map and then approach each other or meet at an agreed upon common point. The system 10a of FIG. 2 can be expanded to track an entire fleet of vehicles or other delineated groups of mobile units for a variety of purposes.

Detailed Description Paragraph Right (13):
According to another mode of operation of the computer aided map location system 10 of FIG. 1, the PDA 15 may have no GPS receiver and capability. The user 12 may initiate operation of the CAMLS system with a query on the PDA such as "Where is Freeport, Me.?" The PDA responds by displaying in the alphanumeric display the unique gridname of the grid quadrangle in which Freeport, Maine is located. The respective grid quadrangle is displayed on the graphics display window of the PDA. A dot or shaped image is presented and highlighted on the grid quadrangle at the location of Freeport, Me. for correlation with surface features depicted in greater detail on the printed paper map as heretofore described.

Detailed Description Paragraph Right (14):
Seeking greater information the user might ask for all e.g., hotels/motels in grid quadrangle US-NE-41-C3, or all e.g. restaurants. These are displayed at respective latitude and longitude locations on displayed grid quadrangle C3 correlated with grid quadrangle C3 of the map on Page 41 of the Northeast Regional Atlas. The displayed image locations can therefore be correlated with locations on the printed map using, for example, mapped surface features depicted in detail on the printed map. Locations of the selected objects such as hotels or restaurants may be derived from databases stored in separate memory devices such as PCMCIA cards inserted in the PDA. External databases can be accessed by wired or wireless data links. Hotels or restaurants may be indicated and displayed using standardized symbols and accompanying text information.

Detailed Description Paragraph Right (15):
Or, the user might request all restaurants in Freeport, Maine in turn located e.g. within the grid quadrangle C3 of the map on Page 41. For this purpose the user may initiate a zooming transition to a third level grid quadrangle within C3 and assigned a unique ID code by alphanumeric indicia associated with the hash marks or subdivision marks which subdivide grid quadrangle C3 of the map at Page 41 of the NE Regional Atlas. On this metro level grid quadrangle representative streets of Freeport, Maine may be available for display in association with the selected loc/objects located by geographical coordinates within Freeport, Me. In this respect, it is apparent that a variety of levels of context or background may be displayed with selected loc/objects identified by geographical coordinates for display on the PDA or other PC display as hereafter described.

Detailed Description Paragraph Right (16):
A variety of locatable objects (loc/objects) may be available for queries posed by the user according to the memory capacity of the PDA, memory devices available to supplement PDA memory with additional internal databases, and data links for accessing

external databases. Such classes of objects may include hotels/motels, restaurants, tourist attractions, destinations, routes, cities, municipalities, transportation services, parks, recreation areas, campgrounds, hospitals, museums, zoos, etc., each shown by characteristic symbols and where appropriate accompanying text identification. For categories of users other than travelers such as city and town planners and officials other classes of objects may be available in supplemental databases such as fire hydrants, classes of buildings, land use categories, municipal infrastructure, etc., again all shown by characteristic symbols, etc.

Detailed Description Paragraph Right (17):
By way of example another mode of operation of the system of FIG. 1 is for routing. The user enters current location and proposed destination. Alternatively, with a GPS receiver and capability, the current location of the user is derived from GPS data and the user enters a proposed destination. The user location and proposed destination are displayed on an appropriate grid quadrangle on the graphics display window of the PDA for correlation with locations depicted in detail on a corresponding printed map. The grid quadrangle is selected at an appropriate grid level to encompass both current location and proposed destination. The user then asks for a proposed route or alternate routes to the destination which may be derived from a database of routes, e.g. on a supplemental memory device. In this respect the routes can be viewed as locatable objects (loc/objects) with geographical coordinates located on the PDA graphics display for correlation with mapped features depicted on the corresponding paper map. Alternatively, routing software such as the Sedgewick-Vitter algorithm described in James A. McHugh, ALGORITHMIC GRAPH THEORY, Prentice Hall (1990) pp 107-108 can be used to determine an optimum route from the user location to proposed destination for display on the selected grid quadrangle.

Detailed Description Paragraph Right (18):
Important features of the CAMLS system of FIG. 1 may be characterized as modality, selectivity, and modularity. Modality refers to the different modes of use of the system summarized above including capability of providing responses to the queries "Where am I?", "Where is Freeport, Me.?", and "How do I get there?" Additional queries can be posed relating to classes of locatable objects (loc/objects) locatable in the selected geographical coordinate system for display on the graphics display and derived e.g. from supplemental databases. The CAMLS system can be operated in a communications mode adding a communications dimension to the mapping data. This varied and rich modality of the invention brings to life the paper maps and gives them a dimension of intelligence not otherwise available to the map reader. All features displayed in simple and bare outline on a grid quadrangle of the graphics display of the PDA or other PC correlate with surface features depicted in far greater detail on the printed map for visual and intuitive correspondence and map reading without mathematical calculation or quantitative determination required.

Detailed Description Paragraph Right (19):
Selectivity refers to system capability that allows the user to select greater or lesser amounts of context and background to accompany a blinking dot display of user location, image display of a proposed destination and proposed route, or loc/objects selected for display on a grid quadrangle. The greater or lesser degrees of background, overlays, or loc/object types, can be used to facilitate user correlation with locations and mapped surface features depicted on the printed maps. By way of example, use of the CAMLS system 10 with a selected level of background context is illustrated in FIG. 3. As shown in FIG. 3, the graphics display screen 18 of the PDA not only shows the user location by arrow 32 of the type illustrated in FIG. 1D, but also two major routes 35,36 and a loc/object 38, for example a well known landmark that may also be accompanied by identifying text. This modest contextual background facilitates correlation by user 12 between the grid quadrangle display on PDA 15 with the surface features depicted on the correct grid C3 of the corresponding paper map of e.g. the NE Regional Atlas 14. The level of detail of this background context can be selected by the user by specifying a priority level of background detail as hereafter described. Such different levels of background detail may be available in the internal PDA memory, by supplemental memory devices such as PCMCIA cards, or by communications links with other databases, information services, and other CAMLS systems.

Detailed Description Paragraph Right (20):
The modularity of the invention refers to the availability of multiple databases,

internal databases in computer memory or in separate modules or memory devices, and external databases through wired and wireless data communication links. This modularity makes possible the foregoing selectivity in the hands of the user, permitting the user to select and pose queries relating to many different classes of loc/objects for display of the graphics display screen of the PDA or other PC and with many different levels of context or background according to the user requirements.

Detailed Description Paragraph Right (21):
An added dimension to each of the foregoing embodiments of the invention is that the databases available for queries on the system 10 are not limited to memory devices such as PCMCIA cards carried with the system. By means of wireless modem and FM and cellular communications links as well as wire modems, the user can query databases for loc/objects and contextual background from central locations, information service bureaus, or other databanks on line or in real time for latest updated information. As hereafter further described essentially unlimited databases and sources of information can be made available to the user for display and correlation with the detailed paper maps of the accompanying atlas as illustrated in FIG. 3A.

Detailed Description Paragraph Right (22):
As database sources of information and contextual background increase in complexity, the CAMLS system appropriately upgrades in system hardware to handle the information load. As shown in FIG. 4, a notebook or powerbook computer 40 becomes the hardware medium for display of selected grid quadrangles and user queried loc/objects. With increased memory and computing capability, the graphics display 42 of powerbook 40 can be used to display at the same time multiple grid quadrangles correlated with a printed map 44. The active grid quadrangle on the display can be highlighted at the grid boundary lines as shown in FIG. 4. The user can select varying degrees of background context for display by specifying a priority level of detail at the keyboard as hereafter described. Such a priority level of background context may include, for example, major highway routes 35,36, as in FIG. 3 to facilitate correlation with the printed map 44 which still depicts surface features in far greater detail than is available on the display of grid quadrangles of the powerbook display 42. Supplemental databases of loc/objects are available to the powerbook 40 on floppy disks and over wireless modem 45 through cellular and FM communications links. Additional spatially related data about the loc/objects can also be queried from the supplemental databases.

Detailed Description Paragraph Right (23):
A further upgrade in CAMLS system capability is illustrated in FIG. 5 using a desktop PC or workstation 50 for further elaborating grid quadrangle displays on the computer graphics display 52 for correlation with the more detailed printed maps of atlas 14. Loc/object databases such as hotel/motel guides 53, restaurant guides, etc. are available on floppy diskettes 54 selected by the user. Extensive information about the loc/objects can be queried by the user from the CAMLS computer. The additional background detail capability for graphics display, also provides the opportunity for printing hard copies of the display on printer 55 providing simplified maps 56 in different formats. With provision of the atlas 14 in the form of CDROM 58 full map making capability for printing more detailed maps is also available.

Detailed Description Paragraph Right (24):
According to another variation of the CAMLS system, the desktop PC embodiment 50 can be used with routing capability and software to generate selected routes from origin to destination. The route can be made available in hard copy in the form of strip maps, trip ticket, or route maps 60 from printer 62. As shown in more detail in FIG. 6, the grid format graphic displays of PC 50 can be made available in hard copy in a variety of formats including strip maps 64, page maps 65, and individual grid quadrangle maps 66. Databases for loc/objects of interest can also be provided on memory devices, on line information services, and other communications links.

Detailed Description Paragraph Right (25):
In the preferred example embodiments according to the invention illustrated in FIGS. 1-6, the grid quadrangles are selected to be approximately square in area in the middle latitudes for example across the northern United States. A typical grid quadrangle size is selected to be for example approximately 2".times.2" (5 cm.times.5 cm). For a NAFTA Atlas, however, the maps and associated grid quadrangles range from

southernmost latitudes in Mexico to northern most latitudes in Canada. Because the preferred geographical coordinate system is the traditional latitude/longitude coordinate system, the longitudinal width of the grid quadrangles would otherwise vary considerably from the selected square area of the middle latitudes at the extreme southernmost and northernmost limits of the NAFTA Atlas range. For example, the grid quadrangles which are substantially square in the mid latitudes will be substantially fatter or wider in the southernmost latitudes and substantially thinner or narrower in the northernmost latitudes while retaining the same height dimension as the aspect ratio changes throughout the range. This variation in aspect ratio presents a visual layout problem in uniform map presentation and appearance over the NAFTA range.

Detailed Description Paragraph Right (26):
According to the preferred example, the maps and grid quadrangles at a selected grid level are also ideally selected to be constant scale throughout the range of interest. The endeavor to preserve constant scale however encounters the dilemma of uniform map presentation and appearance. As a result it is permitted according to the invention to vary the scale slightly at the southern and northern extremes of the range to maintain a uniform number of grids across a map page of the Atlas. For example at exactly constant scale, 8 grid quadrangles may fit across a map page of the Atlas in mid-latitudes while only 7 of the fatter grid quadrangles fit across the page in south Mexico. On the other hand 9 grid quadrangles may fit across the page in north Canada. By slightly varying the scale at extreme ranges, a uniform number of 8 grid quadrangles can be presented across the page for uniform presentation at all latitudes of the range. This slight variation in scale at the north and south extremes of the range to achieve uniform presentation is intended to be and is encompassed within the phrase "substantially constant scale" as used herein and in the claims.

Detailed Description Paragraph Right (27):
A system block diagram of a complete data processing computer system 70 for a high end computer aided map location system is illustrated in FIG. 7. An input bus 211 also designated the event handler 211 performs the initial event handling function of receiving and passing valid data items from a variety of mapping data input sources. The event handler 211 therefore handles data events at, for example, a GPS, LORAN, or FM real time position data receiver 201, voice and data wireless links 202, 203, hardware communications bus, wire link, cable and modem 205, remote and local wired voice inputs with voice recognition 206, 208 user input devices 207, local voice input with voice recognition 208, scanner or paper map reader 209,246 and memory devices 219 which may include hard drives, CDROMS, floppy disks, PCMCIA cards, tapes RAM, and ROM etc. The overall function of the event handler 211 is to read, validate, order and pass all of the mapping information data input items into the CAMLS system under control of the options selector 215.

Detailed Description Paragraph Right (28):
The data processing system 70 of the CAMLS system as shown in FIG. 7 includes hard copy input system 246 with sheet media input 248 and scanner/reader 249 associated with the paper map reader 209. Voice input is provided with voice recognition through wireless 202 and wired 206 remote voice input links and local voice input with voice recognition 208. As also shown in FIG. 7, the mapping data subsystem 210, option selector 215, and mapping display subsystem 213 form part of the microprocessor or CPU 217. Other applications software may be resident in the CPU 217 for operation concurrently or sequentially through interrupts, menu selections, windows, etc.

Detailed Description Paragraph Right (30):
The mapping data subsystem 210 receives valid CAMLS mapping data and other types of mappable inputs from the event handler or input bus 211. Standardized CAMLS data records are fast-tracked through to the mapping display subsystem 213. Optional mapping data subsystem procedures can organize other mappable inputs into standard CAMLS format or loc/object data structures. Data items ordered in the standard CAMLS format or data structure are passed to the mapping display subsystem 213 for possible display/output. FIG. 10 and Tables I, II and III deal with mapping data subsystem 210 operations. FIG. 11 and Table IV concern the mapping display subsystem 213 management of display/output options.

Detailed Description Paragraph Right (33):
The options selector 215 is adjustable and programmable for interacting with the event

handler 211, mapping data subsystem 210 and the mapping display subsystem 213. The options selector 215 facilitates coordination and forming combinations of the optional routines or procedures for data conversion, location assignment, data structure building and output/display disclosed hereafter in TABLES I, II, III and IV respectively. This is accomplished by well known programming methods for managing lists of computerized procedures, as implemented within a generalized options loop for each TABLE. Through appropriate menus, in more capable CAMLS implementations, users can coordinate and combine the optional routines for customized operations using macros or batch files. Automated subprograms provided with "higher end" CAMLS software systems also integrate optional procedures in order to perform advanced CAMLS functions disclosed in the TABLES, such as displaying a scripted series of digital maps, sharing of the map, display by text messages assigned a geographic location, sequencing display of digital map overlays on chosen topics, or voice outputting topical information linked to specific locations as an accompaniment or alternative to map displays for the specific locations.

Detailed Description Paragraph Right (35):
As disclosed in TABLE IV and related specifications on the optional display/output routines, the options selector 215 also enables users and automated subprograms to set different levels of quantitative display intensity or topical subject matter shown on screen. In effect, the user selections or automated routines alter the level of map detail displayed ranging from a virtually blank background and singular loc/object display in a named grid quadrangle to substantially whole map displays which are made up of multiple map overlays or collections of multiple loc/object types. Referring to TABLE IV and the data structure of qualified CAMLS loc/objects disclosed in FIG. 8, the options selector 215 in response to user selection or automated subprograms can declutter and select the output and display. For example, user selection or automated subprograms can cause a graphic display consisting exclusively of major highways, gas stations, natural landmarks, or campgrounds, etc.

Detailed Description Paragraph Right (36):
The mapping display subsystem 213 cooperating with the options selector 215 controls the selection of digital displays 230 including graphics display 233 and text display 235, local voice output 231, 232, wireless and wired remote voice outputs 236, 238, hard copy outputs 240 including printer 242 with sheet media output 245 and analog output controllers 251,252 for wall map display 255 and projector 256. The mapping display subsystem 213 also performs database manager functions in selecting and organizing data for presentation at the various outputs. FIG. 11 presents a flow chart of the mapping display subsystem 213 with related optional output/display procedures disclosed hereafter in Table IV and accompanying description.

Detailed Description Paragraph Right (37):
In addition to or even instead of the graphics display 233, text display 235, and hard copy output 240, the digital outputs 230 of the CAMLS computer system also includes local voice/audio output using e.g. a voice synthesizer 231 and speaker 232. Voice output/sound output can also be transmitted to remote locations over wireless 236 and wired 238 voice data links. The CAMLS system computer output may provide only a voice identification or text identification of a uniquely named grid quadrangle where a loc/object is located. Reference is then made by the user to the corresponding printed map containing the identified grid quadrangle.

Detailed Description Paragraph Right (38):
Additional outputs include an analog output interface 250 for controlling a variety of display outputs. For example, the analog output interface 250 is shown coupled to the control 251 for a backlighted translucent wall map display 255 hereafter described with reference to FIG. 14. It is also coupled to a projector controller 252 for controlling a map and grid projector 256. Additional outputs also include functional or operational outputs such as a line output or odometer style alphanumeric display.

Detailed Description Paragraph Right (40):
The data structure or data item for each loc/object handled by the CAMLS data processing system and integrated into the display data stream is described with reference to FIG. 8. Each data item is characterized by a first header data element which is an ID code identifying the data item by the input device source of the data item, the loc/object type, e.g. hotel, restaurant, campground route, tourist

attraction etc., and the chronological date and time of entry or processing by a date and time stamp. Thus, the event handler 211 and mapping data subsystem 210 can initially organize data items according to input device source, loc/object type, and chronological date and time of entry or processing.

Detailed Description Paragraph Right (41):
The second data element of the data structure of FIG. 8 includes lat/long, the latitude and longitude coordinate location of the locatable object according to the traditional latitude/longitude geographical coordinate system. This data element permits manipulation and display of the respective loc/object in any context according to underlying calculations based on the universal latitude/longitude coordinate system. All grid quadrangles and loc/objects are ultimately characterized within the universal latitude/longitude geographical coordinate system. While other geographical coordinate systems may be used, as noted above, the preferred coordinate system is the universal latitude and longitude coordinate system. The second data element in the data structure also includes the grid name in which the loc/object appears. This enables the CAMLS system to respond to the query, for example, "Where is Freeport, Me.?" by responding with the correct grid name in which Freeport, Maine appears. The grid name data element also permits selection of pertinent loc/objects by grid name for display in response to user defined queries. As used in the specification and claims, "grid name" refers to the unique grid quadrangle name generally specified in alphanumeric characters.

Detailed Description Paragraph Right (42):
The third substance data elements shown in FIG. 8 designated "content" or "link" data elements refer to any associated text information, image shape or symbol characterizing the loc/object, specifically required algorithms, graphics, audio, etc. The data structure illustrated in FIG. 8 is referred to herein as a data structure or data item and when constructed with valid logical contents becomes loc/object which can be selected for display or output on the PDA/PC/EC graphics display or other output format. The grid quadrangles themselves can be viewed as data items or loc/objects ordered and presented in the data structure of FIG. 8. All of the data structures are passed in the order received in a data stream to the mapping data subsystem 210. The separable and intelligible portions of the data stream are thus the data structures or data items which in turn coincide with the locatable objects or loc/objects from more simple points and lines to more complicated geographical and mapping images and including the grid quadrangles.

Detailed Description Paragraph Right (46):
Such a sub-program may be designed e.g. to search both internal and external databases in order to retrieve, and make available for display, information on all facilities of a specified kind e.g. inside of a 50 mile radius around some specified point on the face of the earth. By way of example the sub-program may be an algorithm or a sub-program which performs an operation, like ringing an alarm or initiating a communication, when and if the user of a GPS equipped CAMLS device approaches a pre-selected spot or enters a specified CAMLS grid quadrangle. A complex CAMLS loc/object can still have a relatively compact standard CAMLS data structure if the bulk of its substance is made up of links to other data records. The information is actually stored at specified addresses in internal memory or some accessible external databases. On the other hand, a valid CAMLS loc/object can contain a lengthy document or an extensive database inside of its standard CAMLS data structure among its list of contents.

Detailed Description Paragraph Right (49):
Every particular standard CAMLS data structure, complete and correct enough to qualify as a CAMLS loc/object, must possess an ID necessarily consisting of the three ID elements: an input device stamp; a loc/object type stamp; and a time & date stamp. Each stamp is subject to modification as the particular standard CAMLS data structure is processed within the software. The time & date stamp grants a unique identity to each particular CAMLS data structure. Data structures are stamped one at a time. Therefore there is at least a nanosecond difference between each and every CAMLS data structure. But, many individual CAMLS data structures or loc/objects will often share the same input device stamp or identical loc/object type stamps. For example, several inputs from one GPS position sensor device would share the same input device stamp. Similarly, several comparable units of hotel information will each possess the same

hotel loc/object stamp. In summary, while the unique time & date stamp permits CAMLS software to identify particular individual CAMLS loc/objects, the other two stamps for input device and loc/object type can be used singly or in combination by CAMLS software to sort and group standard CAMLS data structures as required for processing and possible display/output operations.

Detailed Description Paragraph Right (50):
The location data elements in each CAMLS data structure are designed and intended to be somewhat redundant. Lat/longs can be calculated from grid quadrangle names, at least to a limited degree of accuracy or detail. A gridname is readily derived from a lat/long, sufficiently precise. Every unique CAMLS grid quadrangle is identified and located according to one example by the lat/long of its upper lefthand or northwest corner, factoring in its scale or magnitude. Other locations may of course also be used. In the FIG. 10 flow chart for the mapping data subsystem 210, at steps 313, 315, 331 & 335, lat/longs are extracted from gridnames, and vice-versa. These transformations are done by calculation methods well known in the art of computer mapping. Such calculations or transformations, in general, entail formulae for computing XY coordinate relations, taking into account both map scale differentials and map projection variables involving various imperfect spheroid geometries. The result is lat/longs and grid names with calculated redundancy.

Detailed Description Paragraph Right (51):
Data compression in order to save memory or to speed up communications such as facsimile transmissions can be achieved by stripping out grid names. Stripped out grid names then can be readily calculated again as needed, from the retained lat/long location data whenever the compressed CAMLS data structure is retrieved from memory, or emerges at the other end of a streamlined communication between separate devices equipped with CAMLS. However, many routine data building and display processes, as well as obvious buffering techniques for speeding up computer operations, involve searching or retrieving and interrelating many data records associated with the immediate and adjacent grid quadrangles. It is therefore useful to retain a separate entry or blank for grid name location data within the standard CAMLS data structure.

Detailed Description Paragraph Right (54):
The FIG. 8 standard CAMLS record format or loc/object data structure facilitates the workings of the event handler 211, the mapping data subsystem 210 and the mapping display subsystem 213. For example, after performing routine validity tests on incoming inputs, the event handler or input bus 211 utilizes the standard CAMLS data structure to distinguish among mapping, mappable and non-mapping inputs. The preferred embodiment event handler 211 initially process all inputs as raw data packets in the order that the inputs appear at the respective input sources or ports. One alternative input bus 211 embodiment, typically a slower and less portable software process, polls the input sources or ports looking for certain predefined types of input. In either version of the invention, the event handler input bus 211, and the other subsystems, utilize the normative FIG. 8 CAMLS loc/object data structure like an identity tag or benchmark for sorting inputs.

Detailed Description Paragraph Right (57):
The standard FIG. 8 data structure further assures that all mapping or mappable inputs are linked to particular geographical coordinates, according to the preferred embodiment, latitude and longitude. Prepackaged CAMLS loc/objects, the typical discrete contents of a manufactured CDROM map database or geographic data items available from a CAMLS service bureau for downloading on a fee per item basis, will contain location data already installed in the form of lat/longs and related grid names in standard CAMLS data record format as shown in FIG. 8. Open CAMLS systems also process raw data packets which are not located or identified with specific geographic coordinates or lat/long location data. Some examples include user location queries, candidate items selected for location assignment, inputs located within other geographic coordinate systems and nonmapping data passing through the event handler 211 in a multitasking environment. All raw data packets, not discarded or diverted as nonmapping items in the mapping data subsystem 210, became identified with specific latitude/longitude coordinates, for example by means of optional location assignment procedures disclosed hereafter with respect to Table II. All raw data packets are installed in CAMLS format by reorganization into loc/objects modeled on the standard CAMLS data structure shown in FIG. 8 before passing from the mapping data subsystem

210 to the mapping display subsystem 213. Therefore, all loc/objects passed to the mapping display subsystem 213 must possess location data in the form of lat/longs and grid names consistent with the FIG. 8 data structure format. In summary, the FIG. 8 standard CAMLS data structure enables the mapping display subsystem 213 to manage the CAMLS display/output with reference to particular lat/longs along with unique grid names formally associated with all loc/objects.

Detailed Description Paragraph Right (58):
The standard CAMLS data structure plays a vital part in the mapping display subsystem 213, as shown in FIG. 11. For example, steps 403, 407, 411 and 413 concern the naming or display of a new CAMLS grid quadrangle, e.g. when users zoom or shift to a different scale or an adjacent grid. These same steps deal with the case of a moving user location, such as a traveling vehicle in which the user is operating a CAMLS device equipped with a GPS position sensor, when the vehicle moves from one CAMLS grid into an adjacent CAMLS grid. Steps 403, 407, 411 and 413 are engaged whenever the focus of the CAMLS display/output changes to another uniquely named grid. In other words, many operations that prompt new grid display/output can be conveniently described in terms of naming the new grid then changing the display/output accordingly. Another example is the process whereby CAMLS responds to location lookup queries such as "Where is Freeport, Me.?", "Where is the Spruce Point Inn?", or "Where am I?" on a CAMLS GPS equipped device. Such queries get answered by the display/output of the responsive gridname, and typically a map display including the named grid.

Detailed Description Paragraph Right (59):
This same general process of the display/output of a new grid, according to its unique name, is also invoked when the user or an automated subprogram requests the display/output of the grid quadrangle, or a loc/object situated within that grid, corresponding to a set of geographical coordinates like UTM or lat/longs, or specified ordinary location identifiers such as a street address, phone exchange or zip code. The CAMLS software responds to such queries with display/output in relation to the uniquely named grid quadrangle which corresponds to the street address, phone exchange or other ordinary location identifier, or set of geographical coordinates. Of course, steps 403, 407, 411 and 413 also come into play when the user or automated functions actually enter the unique name of any adjacent, remote, smaller or larger scale CAMLS grid, i.e. any valid, unique grid name other than the name of the grid which is currently the focus or subject of the display/output. Entry of a new gridname is done by users entering alphanumeric text, or by clicking a mouse on listed grid names or graphically represented grids, or by various automated processes such as the search and retrieval operations responsive to a location lookup query, as well as optional procedures for sequencing or scripting map display/output concerning a group of grids disclosed hereafter relative to TABLE IV, step 457 and FIG. 15G. In summary, within the mapping display subsystem 213 steps 403, 407, 411 and 413 in FIG. 11 manage all such new grid name events, which impact on the display/output, utilizing particular aspects of the FIG. 8 standard CAMLS loc/object data structure.

Detailed Description Paragraph Right (60):
Operations managed within the mapping display subsystem 213, involving new grid display/output, take advantage of two aspects of standard CAMLS data structure. First, every CAMLS loc/object includes the unique grid name as a location data component in the header portion the standard CAMLS data structure or data record format shown in FIG. 8. Second, also shown in FIG. 8, all CAMLS loc/objects are classified as to types or subtypes within the ID header portion of every standard CAMLS data structure. Hotels, campgrounds, restaurants, streets, political boundaries, users' locations, and water bodies are straightforward examples of types of loc/objects, further classifiable into subtypes for particular display/output purposes. The preferred embodiment of the CAMLS software invention also manages grid names and graphic displays of grid quadrangle boundaries as special types or subtypes of the standard CAMLS data structures or loc/objects. The following two paragraphs detail how gridname location data and gridname types are structured and used for mapping display subsystem 213 tasks.

Detailed Description Paragraph Right (61):
First, here is an illustration of how the mapping display subsystem 213 deals with inputs ordered into standard CAMLS data structures which contain operant new gridname location data and prompt new gridname display/output. For example, take the case of a

series of GPS position sensor inputs, indicating the moving location of a CAMLS equipped user traveling in a car. Each input event would be enrolled in the standard CAMLS data record format and typed as GPS position sensor loc/objects. Thus, all the GPS loc/objects would contain a gridname as a part of the standard location data indicative of the unique grid in which the user is currently positioned. This illustration is first concerned with travel within a single grid and next with the case of travel into an adjacent grid. As long as the gridname location data remains the same because the GPS position sensor is engaged in reporting successive locations inside a single grid, then step 407 in FIG. 11 keeps determining that the current grid name has not changed. But, when the user's vehicle moves into a new grid, adjacent to the grid previously traveled, all subsequent GPS position sensor inputs will contain the new gridname derived from the lat/long location data generated by the GPS sensor. Lat/long location data are transformed to gridnames and installed in the standard CAMLS data structure of GPS position type loc/objects in FIG. 10 in steps 313, 315, and 335.

Detailed Description Paragraph Right (62):
Step 407 in FIG. 11 will determine that this new gridname is not the same as the current gridname of the grid quadrangle just exited by the user's vehicle. Then, step 411 implements the display/output of the new gridname and signals the user with a screen blink or audible beep. Step 413 performs the housekeeping chore of reinitializing the current gridname setting. Direct entry of a new gridname, responses to user location lookup queries, zooming to another map scale, and shifting or scrolling to an adjacent grid or map display are all examples of other processes also executed by the mapping display subsystem 213 as new gridname display/output operations through steps 411 and 413 in FIG. 11. Simple CAMLS devices or operations do no more than cause such display/output of the new gridname at this juncture. For complex CAMLS devices or tasks which involve greater database access, memory and graphic capabilities respond to the process of naming and entering the new grid with optional procedures such as redrawing the map display centered on the new grid, displaying a new selection of map overlays, or an intuitive symbol display representing the user's location, velocity, travel direction, etc. Optional display/output procedures are accomplished in steps 415, 417, 421, and 423 disclosed hereafter in relation to Table IV and for example steps 451, 455, 461 and 463 therein. In summary, many changes in the display/output managed by the mapping display subsystem 213 are prompted by steps 407 and 411 evaluating the gridname location data component of the standard FIG. 8 data structure of loc/object input.

Detailed Description Paragraph Right (63):
Second, at least for more complex CAMLS implementations, not all input containing a new or noncurrent gridname produces the changes in display/output discussed in the preceding paragraph. Complex CAMLS procedures, implemented on higher capacity hardware devices, involve fetching and processing many loc/objects related to multiple grids. Steps 457, 463 and 465 disclosed hereafter in relation to TABLE IV, for example, concern optional and advanced procedures for sequencing map or grid displays, user location or position display/outputs, routing or line segment display/outputs often involving input across a plurality of grids, etc. FIGS. 4, 5 and 6 disclose multiple grid displays. Multiple grid inputs and outputs require a method for distinguishing new grid names meant to alter the current gridname setting. Operant new gridnames, so intended to change the display/output to focus on a new grid, have to be distinguished from noncurrent gridname location data in loc/objects passing through the CAMLS system for purposes incidental to computations and display/output operations involving multiple grids. The FIG. 8 standard CAMLS data record format facilitates this necessary distinction by the designation of special gridname types or subtypes. Loc/objects, containing new or noncurrent gridnames and intended to generate a new grid display/output, get specifically typed for that purpose. Special typing as an operant new gridname is accomplished as part of the process of the user making a selection designed to result in new grid display/output. Step 403 in FIG. 11 recognizes operant new gridname types and passes such loc/objects to step 407. On the other hand, in absence of special gridname typing, step 403 also functions to bypass steps 407, 411 and 413 in the event of loc/objects with new or noncurrent gridnames intended only for incidental and optional multiple grid procedures. In summary, the typing feature of the standard FIG. 8 data structure enables the mapping display subsystem 213 to manage display/output routines involving new or alternative and multiple grids.

Detailed Description Paragraph Right (64):
Furthermore, there is a larger significance associated with the distinction between loc/objects specially typed to prompt new grid display/output versus "plain" loc/objects typically serving as the contents of the current output/display. This distinction coincides with the differential concept of a first database of grid quadrangles, each with a unique name and location, which can interact with a second database comprised of various other types of loc/objects ordinarily displayed as digital electronic mapping content. For a particular graphic map display, the current named grid quadrangle, with adjacent grids in the case of multiple grid display, provides the overall context or framework within which selected loc/objects like road networks, natural features or user locations are displayed within grids at their specific geographic coordinates. Zooming to a larger or smaller grid, shifting or scrolling to adjacent grid, a new operant gridname entered by the user or responding to some user query are all events which reorganize the context or framework of the CAMLS display/output around a new operant gridname. This reorganization of the CAMLS display/output is accomplished, or is at least initiated, through the recognition of specially typed new gridname location data in the standard FIG. 8 data structure embodied in loc/objects which are processed through steps 403, 407, 411 and 413 in FIG. 10.

Detailed Description Paragraph Right (66):
The option loops branching to the right thus function primarily to convert or transform information about geographical locations from formats not understood by the CAMLS software into the standard CAMLS data structure for loc/objects handled by the CAMLS system. Additionally the program option loops can also assign or tie specific geographical locations to various data objects, symbols, graphic images, algorithms, text information, and messages which are otherwise unsituated or unmappable but which the user would like to display on the map. Location assignment for this purpose is referred to as "screen sharing". This process of geocoding generally non-map objects brings them into the CAMLS mainstream for display as loc/objects at specified locations on a map or other forms of output. These option loop subprograms and routines for putting such objects and things at places on maps are referred to herein as selectable and programmable procedures for "geographic data conversion", "location assignment", and "building loc/object data structures" and are shown generally in FIG. 10.

Detailed Description Paragraph Right (69):
A flow chart showing basic operation of the event handler 211 is illustrated in FIG. 9. The event handler provides a path of least resistance to all data inputs organized and structured according to the mapping data structure or loc/object data structure of FIG. 8. Thus appropriately packaged or structured mapping data inputs retrieved, for example, from internal memory 219, downloaded over communications links 203, 205, etc. pass directly on to the mapping data subsystem 210 and mapping display subsystem 213. Other input data such as raw data packets from the radio location or other location sources may not yet be structured in the fully acceptable mapping data structures. Such raw data packets may still be recognized by the event handler as locatable or mappable objects or data structures passed to the mapping data subsystem 210 for appropriate restructuring or reorganization.

Detailed Description Paragraph Right (73):
A flow chart of the overall mapping data subsystem for the CAMLS system is illustrated in FIG. 10. The mapping data subsystem 210 inspects each data item and if not valid or complete attempts to repair or complete the data structure to provide a fully valid data item. The valid data items are then transferred to the mapping display subsystem 213. The option loops for conforming data items to the data structure of FIG. 8 are generally shown in option loops to the right of FIG. 10A while the mainstream of conforming loc/object data structures is shown to the left.

Detailed Description Paragraph Right (74):
In FIG. 10, the first of these option loops at 301, 303, 305, 307, 309 and 311 concerns conversion of mapping data from other formats. The second option loop of FIG. 10, at 317, 319, 321, 323 and 325 involves varied location assignment processes, i.e. operations such as screen-sharing by located messages and geocoding of unsituated objects. The third option loop of FIG. 10 at 341, 343, 345 and 347 deals with the

building of loc/objects according to system standard record structures and display requirements. The fourth option loop appears at 415, 417, 421 and 423 in FIG. 11 and involves optional display routines. Details of the option loops are set forth in TABLES I-IV and accompanying description.

Detailed Description Paragraph Right (75):
The FIG. 10 flow chart shares important features with the flow charts for the event handler 211 and the mapping display subsystem 210, shown in FIGS. 9 and 11 respectively. The FIG. 10 mapping data subsystem flow chart begins at Q where the FIG. 9 event handler flow chart of FIG. 9 ends. The mapping data subsystem 210, as drawn in FIG. 10, ends at B where the FIG. 11 mapping display subsystem flow chart begins. Like the event handler and mapping display subsystem, the flow chart for the mapping data subsystem includes a fast-track for priority items like grid names, position sensor data as well as loc/objects already built in the standardized CAMLS data format. This fast track for dropping through qualified loc/objects runs down along the lefthand side of FIG. 10, much the same as FIGS. 9 & 11. The branches of the flow chart extend horizontally to the right across the page in FIGS. 9, 10 and 11 and show optional procedures.

Detailed Description Paragraph Right (76):
FIGS. 10 and 11, flow charts for the mapping data and display subsystems respectively, both make specific use of generalized options loops, for example compare 301, 303, 305, and 307 in FIG. 10 with 415, 417, 421 and 423 in FIG. 11. These options loops take the form "do prime procedure" followed by "do next enabled procedure", until the current listing of procedures is exhausted. Option loops addressing selectable, programmable lists of routines or procedures are set forth in TABLES I-IV. The options selection lists are not static and are not performed in the same rote order at all times and in all modes of operation. Rather the options lists are variable or dynamic subject to automated changes and user input implemented by the software itself and manual adjustments or menu selections by the user.

Detailed Description Paragraph Right (79):
Screen sharing is not limited to messages. A time and place location might be assigned to a function like placing a call to a selected phone number as well as a received message. Thus, at breakfast, a homebound spouse can program the commuting worker spouse's PDA to CALL HOME, during the usual commute home, from a selected location. The PDA proceeds to wake up and place the call from the commuter's vehicle when GPS position sensor data coincides with the selected place e.g. the neighborhood grocery store, within the proper time frame e.g. 5 to 6 PM. No call issues if, in the course of the working day, the commuter spouse passed by the selected location, on a job-related errand, for example. A pleasant, characteristic, audible signal tells, or reminds the user about the preprogrammed call as it is being placed. The screen display reveals how and to whom the call is being made in the form of a text display, or the same information might be conveyed by a synthetic or prerecorded voice message. The screen can display the location being called cartographically i.e. by highlighting the marital home on a graphic map display.

Detailed Description Paragraph Right (80):
For the preferred embodiment, TABLE I below comprises the user-selectable, programmable and amendable listing of optional procedures and sub-programs managed by the options selector 215. These options are implemented in the options loop shown at steps 303, 305, 309 and 311 in the FIG. 10 flow chart for the mapping data subsystem 210. In this options loop are performed data conversion operations which translate information expressed in other geographic data formats, or other non-CAMLS data structures, into at least partially complete, standard CAMLS data structures generally described in FIG. 8. The successful results of such data conversion operations then become eligible for further processing and completion within the mapping data subsystem 210 and thereafter for possible output/display routines in the FIG. 11 mapping display subsystem.

Detailed Description Paragraph Right (89):
353: CONVERSION PROCEDURES FOR PROPRIETARY DATA FORMATS An array of conversion procedures for data conversion from a variety of other commercially significant, proprietary formats for digital geographic data e.g. Map info (TM), ESRI (TM), Intergraph (TM), GDT (TM), ETAK (TM), Automap (TM), Thomas Bros. (TM), etc. into the

corresponding standard CAMLS data structures.

Detailed Description Paragraph Right (90):
355: CONVERSION ROUTINES FOR GRAPHIC DATA An array of conversion routines for graphic data in various universal or public domain geographical coordinate systems and grid systems, used both in digital databases and on printed maps which are scanned into CAMLS, e.g.: State Plane, UTM, US Air Force System, Ordinance Survey Maps, standard lat/long grid systems graphically presented in digital or printed form according to various map projection geometries. These are transformed or converted into the standard CAMLS format and grid system for cartographic data.

Detailed Description Paragraph Right (91):
357: CONVERSION ROUTINES FOR RASTER DATA, SYMBOLS & ANNOTATIONS An array of conversion routines for conversion of raster data consisting of mapping graphics and related text, derived from input devices such as scanned in paper maps, message pads, digitizing tables, graphics and CAD programs, fax and wireless data transmissions into standard CAMLS data structures. These conversion routines read standardized, pre-defined CAMLS symbols and markings easily made by handheld pencil, pen or the equivalent digital pen or mouse or drawing device. Such symbols may include an X inside a circle representing a freshly geocoded site, or an H within a box as a hand-writable and digitally readable convention for hotel, certain kinds of dotted lines or double lines as political boundaries versus roads, etc. This facilitates geocoding and making other map annotations on printed paper maps for later scanning into CAMLS software as well as receiving input from pen-pad type digital devices.

Detailed Description Paragraph Right (97):
In TABLE II below, steps 367-371 include location assignment routines, termed geocoding, which apply to a broad variety of digital objects representative of entities assumed to exist at a specific natural geographic location such as a hotel, a town or the current position of a person or a vehicle. Steps 373-378 involve a second set of location assignment operations termed "located output and operations" applied to digital objects not possessed of an inherent or natural geographic location such as text messages, alarm signals, and functional operations like placing a communication. This is also referred to as screen sharing. Step 380 is an empty seat or open slot to facilitate the addition of further location assignment procedures provided on tangible digital media or downloaded via communications links. Step 381 analyzes CAMLS loc/objects which have undergone location assignment routines checking for specific indicia of completeness and correctness and also performing error correction, defect rejection and retyping functions.

Detailed Description Paragraph Right (99):
368. GPS QUERIES: An array of location assignment routines for responding to user queries such as "Where am I?" or "Where is other GPS equipped device?". The responding routines are based upon location data from a position sensor input device, typically a GPS sensor. The position sensor is directly connected to user's own device; or location data communicated from another GPS equipped device is downloaded at user's device.

Detailed Description Paragraph Right (100):
369. PUSH-BUTTON GEOCODING: An array of geocoding routines, performed by the user of a range of CAMLS devices whereby upon pushing a button, or otherwise entering a specific command on the CAMLS device, an instruction is given to the CAMLS software for the assignment of a specified location to a particular digital object selected by the user for location assignment. The assigned location data is based upon the current position sensor data on devices equipped with enabled GPS or upon user selection of a particular gridname or a cursor position displayed within a map grid quadrangle for CAMLS devices not equipped with GPS or an equivalent position sensor.

Detailed Description Paragraph Right (101):
371. RECORDING REMOTE GEOCODING: An array of location assignment recordation routines whereby CAMLS software memorizes locations assigned to digital objects by users at remote sites. The recorded geocoding or location assignments are transported or transmitted to a CAMLS software equipped device in various formats. These may include database records or text files recorded on tangible media in digital format or downloaded via communication links between computer devices and voice input

communicated from a remote site and assimilated by suitable voice recognition software. CAMLS printed maps can also be annotated or marked at the remote site by hand using standard symbols and terms that CAMLS software can recognize. The maps are thereafter transported to, and scanned into, a CAMLS software equipped computer device.

Detailed Description Paragraph Right (103):
374. PANIC BUTTONS: An array of location assignment routines which result in an alarm, or characteristic signal, or a message being communicated to a remote receiver e.g. a dispatcher or public safety agency in conjunction with location data. This alarm or message is triggered by users entering specified commands on a CAMLS equipped device, or by certain predefined input from a sensor device that can detect a collision or the unauthorized entry or use of a vehicle. Location data is based on the GPS position sensor, or other user location detectors, or by users' entry of current estimated location, or in accord with a preset location on stationary devices.

Detailed Description Paragraph Right (104):
376. SCREEN SHARING OR PLACED OUTPUT: An array of location assignment routines which facilitate output/display of text messages, graphics, sound or prerecorded or synthesized voice output by CAMLS equipped devices on the output/display associated with specified locations chosen by the user. Priorities for output/display are controlled by user selection or automated programming. A user or another party, can enter messages for the user such as "BUY MILK ON THE WAY HOME" or "PICK UP SUZY AT DAY CARE". The entered message is expressed on the user's CAMLS PDA or other device equipped with GPS, as voice or text output, directly as a function of the user location, i.e. approaching a specified destination, entering a predetermined unique CAMLS grid quadrangle, or straying off a predefined route of travel or outside of a preselected geographic area.

Detailed Description Paragraph Right (105):
377. LOCATED AUTOMATED OPERATIONS: An array of location assignment procedures or subprograms which automatically implement a desired operation on a CAMLS PDA equipped with GPS or another equivalent position sensor as a function of the CAMLS PDA location, e.g. approaching a specific location, entering a predetermined unique CAMLS grid, or straying off a predefined route or outside of a preselected geographic area. The CAMLS PDA implements a specific operation in response to the location data derived from the GPS position sensor. For example, approaching a certain place, the CAMLS PDA outputs an alarm or a message immediately audible or visible to the PDA user. A preselected point along a planned route, the CAMLS PDA places a communication or sends a signal to a remote receiver. A CAMLS in vehicle security device disables the vehicle engine and issues a prominent alarm in response to position data indicative of the vehicle being driven into an unauthorized area.

Detailed Description Paragraph Right (106):
380. OPEN SLOT FOR ADDITIONAL PROCEDURES: An empty seat or open slot in this programmable list of location assignment routines facilitating amendment or additions to the list. For example, the open slot permits downloading supplemental routines from a central service bureau or facilitates use of an updated or new location assignment routine supplied in object code form on tangible media.

Detailed Description Paragraph Right (116):
By installing this location data in the standard CAMLS data structure embodying the user query on the spruce Point Inn, step 367 transforms the query into a CAMLS loc/object capable of the desired locational response. In other words, the loc/object produced by prior step 367 can facilitate text or voice output of "BOOTHBAY, Me." in response to the user query. The resulting loc/object is now also able to facilitate the display of the corresponding lat/long or gridname or to center a responsive map display Boothbay, Me. Inexpensive, low-tech CAMLS look-up devices, such as a handheld electronic gazetter, can perform such simple location look-up or geocoding routines. A simplified CAMLS look-up device need not possess capabilities to seek and facilitate output of additional information, beyond the hotel location, related to the Boothbay, Me. Spruce Point Inn.

Detailed Description Paragraph Right (122):
For all implementations of CAMLS software, basic voice/text output of current CAMLS

gridname is implemented by step 411 in FIG. 11. All additional output/display options can be disabled at step 415. On all CAMLS equipped devices, step 411 without more suffices to handle the output/display for location "look-up" operations answered only by voiced or textual CAMLS gridnames. With no other output capabilities, step 411 also suffices for certain simple CAMLS devices such as pager style communication devices offering a brief text display confined to CAMLS gridname output. Step 411 still provides the essential CAMLS gridname text/voice output even when further options are enabled at step 415.

Detailed Description Paragraph Right (123):
For example, even in the case of an optional map display involving at least part of step 461 in TABLE IV to place a loc/object on screen, step 411 is still responsible for the odometer style text display of the relevant CAMLS gridname. As a practical matter however, most CAMLS software implementations and most CAMLS devices engage one or more of the optional output/display routines executed by the mapping display subsystem 213 at steps 417, 421 and 423 in FIG. 11. Step 415 provides for user or software control over access to the display/output options loop. The display/output TABLE IV, presents more detail on the specific functional contents of the display/output options loop of the mapping display subsystem 213 accessed through step 415.

Detailed Description Paragraph Right (125):
The TABLE IV programmable, user selectable and amendable procedures and subprograms are managed by the options selector 215 and are implemented in the options loop at steps 415, 417, 421 and 423 in the FIG. 11 flow chart. In this loop are performed all optional operations relating to display or output from the CAMLS software system, all except the most basic text/voice output of the current CAMLS gridname, accomplished in steps 407, 411 and 413 in FIG. 11. Consistent with the invention objects of modularity, selectivity and intuitive map reading, all CAMLS equipped devices are capable of conveying location information at least in the form of text or voice output of the current CAMLS gridname. A low tech handheld location lookup device, for example a CAMLS wrist watch or pocket calculator electronic gazetter, can respond to simple location queries with brief text displays or voice outputs of the pertinent CAMLS gridnames based upon steps 407, 411 and 413 in FIG. 11.

Detailed Description Paragraph Right (126):
Another application relates to mobile users, running or driving a vehicle. The driver needs to keep eyes on the path or road ahead. Mobile users therefore tend to prefer audio output over distracting visual displays. Portable and in vehicle CAMLS devices can provide location information via audio voice output of CAMLS gridnames based on steps 407, 411 and 413 in FIG. 11, without exercising the optional display/output routines disclosed below in TABLE IV. Practically, all other applications of the CAMLS technology for example, any added alphanumeric information text output related to the named CAMLS grid, and all visual graphic map displays use one or more of the optional routines as disclosed in the TABLE IV display/output procedures, below.

Detailed Description Paragraph Right (127):
445. TEXT/VOICE OUTPUT RELATED TO CURRENT GRIDNAME: An array of text/voice routines to output verbal information related to the current gridname output. Step 411 in FIG. 11 executes the basic text/voice output of the current gridname. The verbal information is presented in a literal text format such as alpha-numerical display, or as a prerecorded, synthesized or live human voice. The content of the verbal information includes both information naturally or geographically related to the current named CAMLS grid and text/voice messages, documents or communications which are assigned for output with respect to the current named grid quadrangle. Step 376 in TABLE II describes screen sharing or "placed" output.

Detailed Description Paragraph Right (128):
447. ANALOG OUTPUT ROUTINES: An array of analog output routines for the interface shown at 250 in FIG. 7 to manage and implement various extended mapping and location displays. Such displays include backlighted wall map displays as shown in FIGS. 14 & 15B and 251 & 255 in FIG. 7 and projections, like movie or planetarium projector technologies, involving still or moving mapping images or precisely focused light spots projected against a background screen or image, or through a translucent or transparent media possibly printed with mapping imagery or CAMLS grid lines. The

projected map images or spots of light represent specific geographic locations or CAMLS loc/objects as shown in the FIG. 7 block diagram at 252 and 256.

Detailed Description Paragraph Right (130):
451. GRID QUADRANGLE DRAWING ROUTINES: An array of graphic display routines for digital drawing of CAMLS grid quadrangles, grid lines, multiple grids, nested subgrids, grid "hash marks" in pixel form, and other specialized CAMLS grid displays such as graphic enhancement of zooming and shifting operations, "split" screens, map or grid windows or hyper-cards, scripts or series of grid displays, multigrid displays for tracking or mapping routes, pipelines, rivers, migrations, transmissions, trajectories, dispersion of pollution, weather fronts, and other widespread geographic phenomena located typically within and across a group or groups of CAMLS grids.

Detailed Description Paragraph Right (131):
453. MAP DETAIL LEVELS AND DECLUTTERING OPTIONS: An array of display/output routines which facilitate user selection as well as automated control of variable densities of information visually and graphically displayed or otherwise output by the CAMLS software. High, middle or low levels of detail are determined on a quantitative basis by limiting the length of alphanumerical text output, or the ratio of active versus inactive pixels on the screen, or the overall quantity of CAMLS loc/objects allowed on screen, or putting caps on the size of CAMLS display lists or buffers, etc.

Detailed Description Paragraph Right (132):
455. MAPPING THEME, OVERLAY AND SUBJECT MATTER OPTIONS: An array of display/output routines to facilitate the user selection and automated control of the CAMLS output/display for making qualitative decisions about the specific subject matter, map overlays or themes to be included in the CAMLS display/output. For example, this step enables display/output of map themes or overlays comprised of any of the following loc/object types e.g.: roads and highways, topography, political boundaries, hotels and motels, shops, campgrounds, transportation facilities, public safety agencies, tourist attractions, eating places, municipal infrastructures such as water mains and sewers, atmospheric phenomena such as wind and weather patterns, flora and fauna and demographic data.

Detailed Description Paragraph Right (133):
457. SEQUENCING AND SCRIPTING DISPLAY/OUTPUT: An array of display/output routines for arranging series and synchronized assemblages of mapping displays, text/voice outputs, analog and functional outputs, plus topical temporal arrangements like sequences and synchronizations of maps and CAMLS grids, map overlays, serial displays of local attractions and accommodations, travel scenarios, ordered lists of text/voice output of located information, associated graphic and audio scripts, etc.

Detailed Description Paragraph Right (134):
459. ALARMS, SCREEN SHARING AND INTERRUPTS: An array of display/output routines facilitating automatic control and user selection of the duration, precedence, portion of screen display or other output dimension that is shared or preempted by concurrent or collocated loc/objects such as the ongoing mapping display/output with a variety of located content such as alarms, signals, communications and messages, with variable urgency or priority. These are assigned to share or interrupt the CAMLS display/output at a particular place or location, within or outside of a specified geographic area, or in relation to some equivalent locational situation or set of conditions.

Detailed Description Paragraph Right (135):
461. LOC/OBJECT DISPLAY ROUTINES: An array of graphic display procedures for the location, display or implementation of all qualified CAMLS loc/objects within the appropriate CAMLS grid quadrangle or quadrangles. Complementary procedures are taken into account if applicable such as step 453 on display detail level, step 455 on display subject matter options, step 457 on display sequences and synchrony, step 459 on screen sharing, etc.

Detailed Description Paragraph Right (136):
463. SPECIAL POSITION DISPLAY ROUTINES: An array of output/display operations for the correlation, processing and output/display of current position information as derived from position sensor technologies, such as GPS, Loran-C, other radio positioning systems, or dead reckoning systems computing gyrocompass, wheel rotation and similar

inputs. A range of user selectable, programmable output/display options are provided including text/voice output of grid names and related text/voice output on current position, the basic "blinking dot" graphic position display, the "arrow with hole in head" graphic display of position, speed and travel direction, the coordinated output or display of two or more positions, "breadcrumb" displays recording actual paths traveled, etc.

Detailed Description Paragraph Right (137):
465. ROUTING AND OTHER LOCATED PATH OUTPUT/DISPLAY ROUTINES: An array of output/display procedures concerning optimum, intended, historical or possible courses through, under, on or above land and water including flight paths, road or highway travel, railroad, foot, cycle and hiking trails, water voyaging, trajectories, various pipelines, transmission wires as well as light or radio wave transmission paths and patterns, utilities, public works, other extensive infrastructures, etc. Output/display is based upon algorithms for routing or infrastructure planning, or prerecorded line segment and vector data. output/display modes range from voice/text output of CAMLS gridnames and related voice/text information on courses, routes or infrastructures to multigrid quadrangle, multimedia displays including mapping graphics.

Detailed Description Paragraph Right (140):
A flow chart of the mapping display subsystem is illustrated in FIG. 11. The mapping display subsystem 213 checks the current grid quadrangle name of the currently displayed grid quadrangle and whether a new grid quadrangle name has been entered. If so the gridname is updated and the data subsystem shifts or zooms to the new grid quadrangle for display. The mapping display subsystem also checks on the display options associated with the new grid quadrangle. The mapping display subsystem checks the optional display routines called for by the mapping data subsystem, options selector, and user for actuating the appropriate output devices. The mapping display subsystem performs some database manager functions in selecting and organizing the data for display on the appropriate output devices. Example optional display routines for steps 415, 417, 421 and 423 of FIG. 11 are summarized above in TABLE IV.

Detailed Description Paragraph Right (142):
Step 455 is implemented largely around the CAMLS loc/object type stamp, as embodied in the standard CAMLS data structure shown generally in FIG. 8. For example, in a typical CAMLS database, there may appear loc/object types such as hotels and motels, shops, gas stations, campgrounds, restaurants, public safety services, tourist attractions, transportation facilities, public buildings and parks, etc. The foregoing list is not exhaustive and indicates only a partial account of CAMLS loc/objects typically depicted as points on printed and digital maps. The same prepackaged CAMLS database also may have a selected sample of vector or line segment CAMLS loc/object types, such as back roads, streets, roads and highways, railroad lines, transmission lines, political boundaries, topographic line data e.g. terrain elevation lines, planned or historical routes, lines of position for navigation and piloting, hiking trails, trajectories, rivers and streams, and others. Moreover, this exemplary CAMLS database may include at least some of the following polygon loc/objects types: water bodies, areas covered with characteristic vegetation (or possessing some other natural attribute), property tracts, townships, counties, nations and other political units, market areas, etc.

Detailed Description Paragraph Right (143):
Step 455 provides for user selection and automatic prioritization for the purposes of output/display primarily among loc/object types, such as the sample listed above. Step 455 can also sort on technical, rather than topical, features of CAMLS loc/objects such as points versus vectors versus polygons or the other characteristic elements in completed CAMLS data structures, i.e., the Input Device or Time+ Date stamps. Sorting on these latter characteristics facilitates giving priority for CAMLS display/output on the basis of input source (e.g. GPS sensor) as well as input age i.e. the latest versus next latest versus first in time and other temporal factors.

Detailed Description Paragraph Right (145):
In addition, a preferred embodiment of CAMLS software achieves editorial control by sorting certain loc/objects for voice/text output in association with a graphic mapping display reserved for other loc/objects, as part of steps 453 or 455. For

example, CAMLS PDAs can be programmed to show roads and hotel locations on screen while simultaneously talking to the user, through audio voice output, about local tourist attractions and shops.

Detailed Description Paragraph Right (146):
One feature of the CAMLS software invention provides integrated printed maps and digital displays in which loc/objects sorted by type are printed onto mylar or other transparent media. Step 455 facilitates the printing of a transparent overlay of hotel locations for example, consisting of the list of hotel locations for a particular unique CAMLS grid quadrangle selected for display. Contemporary noncomputerized graphic arts technology for printed maps makes extensive use of such printed transparent map overlays. Step 455 also enables the CAMLS software to print out hardcopy mylar hotel location overlays or thematic maps printed on opaque paper or other media. The resulting printed map output concentrates on selected mapping themes or overlays for specified CAMLS grid quadrangles for example, hotel locations and facilities.

Detailed Description Paragraph Right (147):
Step 455 facilitates user selection of map themes or overlays. For example, while driving in a car, CAMLS users will usually prefer a display concentrating on the road ahead, detour, exit, intersection and hazard information. But, when users stop in some particular place, they can then use step 455 to command display or output of information on the surrounding places to stay, shop, play and eat instead of information on the road ahead and driving conditions. Automated switching can be provided between a display focused on road information and a display focused on local hotels, restaurants and other attractions.

Detailed Description Paragraph Right (148):
Step 457 facilitates simple sequencing plus more elaborate temporal arrangements of CAMLS output/displays. Step 461, even when moderated by steps 453 or 455, can result in a cluttered graphic display of all of the CAMLS available loc/objects related to the current grid quadrangle at once. Step 457 displays selectable loc/object types in a revolving temporal series. For example, a CAMLS equipped PDA, with access to a comprehensive set of databases, displays streets in some city area the user is about to visit. Instead of an overly cluttered simultaneous display of all points of interest to the user, step 457 enables the CAMLS software to implement sequences of topical displays, one at a time. For example, a user can display local hotels and motels for 30 seconds, then restaurants for 30 seconds, then cultural events for 30 seconds, etc. The display sequence can repeat automatically. The user can elect to skip ahead or jump back to the 30 second display about the topic currently of greatest interest.

Detailed Description Paragraph Right (149):
This revolving or sequenced mode of display has many advantages. Cluttered hard to read maps are avoided on screen. The user can compare local hotels, then browse shops and restaurants, in a manner that is consistent with everyday thought patterns and immediate goals for organizing one's personal agendas on a trip. Step 457 allows the business traveler to choose a revolving display series related to work objectives. The leisure traveler can select a different set of revolving displays that focus more on culture and recreation. Step 457 also enables the user or the CAMLS software to alter or adjust the duration and order of the revolving display. Step 457 facilitates user selection or automated subprograms to implement output/display of greater or lesser topics in sequences or temporal series with topical variability across the spectrum of available CAMLS loc/object types in conjunction with step 455. Furthermore, the user or an automated CAMLS subprogram can use step 457 to implement a mix of graphic visual display and voice output within a sequence of topical output/display. For example, hotel locations can be shown on screen for 30 seconds accompanied by audio voice output of local restaurant information.

Detailed Description Paragraph Right (150):
Step 457 provides for the programming within the CAMLS software of complex travel scenarios and mapping scripts. The fundamental procedure is a simple sequential output/display of a list of named CAMLS grid quadrangles or groups of adjacent or related grid quadrangles. For example, business users can select company addresses in order to prompt a revolving display of corresponding CAMLS grid quadrangles within

457. The order of the output/display can be alphabetical, by proximity to the user's present location, or in some other order determined by known factors such as the company's financial resources or history of purchasing from the user's company. Step 457 can generate similar lists of grid quadrangles for output/display along specific computer or prerecorded routes.

Detailed Description Paragraph Right (151):
Thus, the user or an automated CAMLS subprogram is enabled to play, or display, logical or even random sequences of grid quadrangles such as a series of maps on a planned or historical route. Step 457 facilitates the display of each map or grid quadrangle on screen for a specified time. Alternatively, or as an audio accompaniment to a graphical display of a sequence of maps or grid quadrangles, step 457 can be combined with step 445 to permit voice output of information on selected topics related to grid quadrangles or displayed maps in series. Moreover, step 457 facilitates user selection or automated manipulation of the logical or temporal order of the display/output sequences. Grid after grid, or map after map, can be the subject of graphic display, or other output, in accord with the order of travel, reverse order of travel, according to a ranking or priority chosen by the user or computed by an automated CAMLS routine, or according to criteria of proximity to a specified location, or by a variety of other logical, or contingent, sequences.

Detailed Description Paragraph Right (152):
Complex travel scripts or map scenarios can be constructed using routine procedures from step 457 in combination with other CAMLS display/output routines. For example, presentation of a proposed vacation itinerary made by CAMLS software can be programmed to "zoom" to a more distant map scale and then to "speed" over long stretches of anticipated highway travel which lack sights to see and places, topics, or loc/objects of interest. But, when the travel scenario or presentation "arrives" at a place of special interest, the rate of apparent travel slows down, and the display zooms down to closer scale maps, revealing more local detail. Once at places of special interest, this step 457 map presentation can then be interrupted by video of local sights and sounds, a menu to allow interactive audience choice over the topical display/output, an overdrive button so users can "speed" on to the next place of interest, a reservations menu to book local accommodations and get tickets for sporting or cultural events plus transportation via agents or communications links, etc. Step 457 facilitates display/output of travel scripts and map scenarios by processing lists of maps in combination with other CAMLS display/output routines.

Detailed Description Paragraph Right (153):
Step 457 also plays a critical role in tracking and routing vehicles travelling in the field. Using GPS, CAMLS equipped devices are also capable of performing real time route calculations. In the event the vehicle strays off of the prescribed course, step 457 with other CAMLS routines, such as steps 463 and 465 facilitates the display/output of corrective action showing the user how to resume the original route. Step 457 can also determine on the fly how to take a new optimal route in response to the off course position data. Position information can be sensed by GPS or equivalent location detectors.

Detailed Description Paragraph Right (154):
In the case of straying off a prescribed course, step 457 displays where the user made a wrong turn and displays maps of alternative corrective actions. The computation of a new optional route or a plan to backtrack to resume the original course uses steps 463 and 465. The general process for course corrections is as follows. First, deviation from a prescribed course is detected by a subprogram monitoring conformity of route actually taken with prescribed route. Second, along with altering the vehicle operations, the CAMLS system responds to deviation from prescribed course by making the vehicle's current off-course position the starting point for a new route calculation. Using a routing algorithm, or a pre-recorded list of routes, steps 463+465 compute optional routes back to the prescribed course or onto the original destination. Step 457 allows the user to display these new corrective courses as a sequence or series of maps or guides to aid in deciding how to proceed.

Detailed Description Paragraph Right (155):
Step 459 governs user selection and automated programming of the parameters by which CAMLS output/display is interrupted, or shared, by loc/objects competing for time and

space on screen or other outputs. The issue generally resolved by step 459 routines is whether the ongoing graphical map display or other output of location information must give way in some degree to alarms, signals, communications, text messages, even software operations, etc. These signals have been assigned a location through operations such as steps 376, 374 & 377 in the table of optional location assignment routines, TABLE II. Step 459 facilitates a range and combination of responses as follows: (1) full and continuing interruption of the ongoing output/display; (2) a priority signal or alarm giving the user the option to interrupt ongoing display/output; (3) sharing a low priority portion of the screen space; (4) a delayed, short term interruption fit into the next pause in audio output; (5) memorizing text messages or saving of an operation for later review or implementation; or (6) ignoring or declining potential interrupts all together.

Detailed Description Paragraph Right (156):
Step 459 plays a role even on CAMLS devices not equipped with position sensors such as GPS. Located screen sharing can take place just because the user or an automated function chooses to display a certain CAMLS grid quadrangle or group of grid quadrangles, or a geographical point or line or area to which a particular text message, or a specific operation, has been assigned. Located screen sharing can also be used for advertising. Further applications of step 459 require position sensor data from GPS or the equivalent. Thus, the user entering or leaving a specified location, with her GPS equipped CAMLS device, becomes a potential trigger for alarms, messages or operations modulated by step 459. In other words, a subprogram can employ step 459 to allow more interrupts and screen sharing to displace basic road information display/output while a vehicle equipped with CAMLS and GPS is proceeding along a stretch of uneventful highway, as determined by distance from exits, hazards and detours. The subprogram encourages interruptions and screen sharing also (1) when GPS has detected the vehicle stopped for a time and (2) when GPS has detected travel in an area frequented by the user by comparing current position to travel history kept in memory.

Detailed Description Paragraph Right (157):
Step 461 provides routines for the display/output of CAMLS loc/objects. Loc/objects are broadly defined to include not only cartographic representations of natural geographic entities such as rivers or towns, but also abstract phenomena such as political boundaries or planned routes, lines and polygons, point data, and even unsituated documents data or functions which have been assigned specific geographic locations. Conceptually, step 461 goes forward "mindlessly" proceeding to display graphically or describe with voice output all of the CAMLS loc/objects available in all accessible databases or new input. On more powerful CAMLS devices such as advanced PDAs and laptops, and desktop PCs with access to abundant CAMLS databases and inputs, step 461 typically is implemented in restricted form to narrow the possible range of loc/objects which are eligible for concurrent display. Steps 453, 455, 457 & 459 function to select, sequence and prioritize the loc/objects available for output/display.

Detailed Description Paragraph Right (159):
Step 411 in FIG. 11 facilitates text or voice output of the current gridname in response to corresponding input from GPS or equivalent position sensors. Step 411 names the unique CAMLS grid quadrangle currently occupied by the GPS equipped CAMLS device.

Detailed Description Paragraph Right (160):
A momentary, pinpoint graphic display of current position, derived from GPS or its equivalent, can be achieved by step 461 treating each successive position data input as an individual loc/object. GPS equipped CAMLS devices can utilize step 463 to compute, output or display position information derived from computing relationships between the most recent position input and the previous position data input. This enables determination of speed, travel direction and recordation of the path of travel. Step 463 also handles any display of multiple positions e.g. as shown in FIG. 2. Step 463 may also provide GPS altitude data. The altitude data has utility not only for aircraft applications but also to detect elevations on earth.

Detailed Description Paragraph Right (161):
In preferred CAMLS embodiments, particularly in vehicle applications and related

travel planning, step 465 provides display or output related to so called routing algorithms, or line segment route descriptions either prerecorded in memory or input into the CAMLS software. Step 463 prompts text or voice output of names of CAMLS grid quadrangles and related information on a route, with step 445 as well as graphic display of routes. Step 465 is not limited to routes but covers a broad range of cartographic vector, line segment, even polygon data. Road networks can be digitized as polygons. Step 465 presents a nonexhaustive list of specific geographical phenomena readily represented as line segments or related digital geometric forms. Step 465 also covers abstract cartographic line data such as political boundaries, line and fill graphical entities representing the broadest range of demography, weather, flora and fauna, terrain, hydrography and man made phenomena.

Detailed Description Paragraph Right (162):
The review of TABLE IV display/output options by the mapping display subsystem includes checking whether graphic enhancements are to be displayed augmenting the background or context in the current grid quadrangle. Second, the mapping display subsystem 213 determines what loc/objects are to be displayed in the selected grid quadrangle and whether further text messages should be included. After determining what other map details are enabled for display, the mapping data subsystem checks whether any classes of loc/objects or map details should specifically be removed to "de-clutter" the display at the command of the user. Subsystem 213 also checks whether any of the voice output options are enabled.

Detailed Description Paragraph Right (163):
TABLE IV optional display/output routines are readily combined by automated subprograms. For example, in the case of a user traveling with a CAMLS GPS equipped PDA, a subprogram automatically modifies and adjusts the displayed mapping detail as a direct function of velocity and direction of travel. This subprogram is implemented as an aspect of the workings of the FIG. 11 options loop involved in optional display routines. For example, the list of display procedures and routines for this display options loop appears in a general form at steps 415, 417, 421 and 423. Automated changes in the subject matter of the CAMLS output/display as a function of GPS sensor data on rate of speed are accomplished by a combination of steps 455 and 463.

Detailed Description Paragraph Right (164):
One routine concentrates on displaying information on moving vehicle position, direction of travel, speed and details concerning the road ahead pertinent to driving. Another of the procedures in the display OPTIONS loop de-emphasizes or eliminates display of vehicle position and related information opting instead to display information on facilities and attractions surrounding the current position of the PDA with GPS e.g. hotels, restaurants, campgrounds, tourist attractions, shops, hospitals and police stations. The road ahead versus surrounding displays are straight forward applications of step 455. GPS determined switching is a step 463 routine. Step 463 can also focus display in front of the direction of travel, de-emphasizing display behind or off to the sides of the present apparent travel direction. Consistent with concepts that the listed procedures in every options loop are selectable and programmable through the options selector 215, the GPS equipped PDA can switch back and forth quickly between two different display routines such as the alternative routines described above. The final step in picturing this display subprogram is to visualize that the options selector 215 is programmed to switch from one routine to another depending on the velocity and direction of travel of the GPS PDA user's vehicle.

Detailed Description Paragraph Right (165):
Suppose the user and the GPS equipped PDA are in motion, as determined by the GPS measurements of immediate velocity. The options selector 215 is automatically adjusted to concentrate on displaying position, speed and the road ahead. What is ahead is determined as a function of GPS derived data on direction of travel. This adjustment is accomplished, within the FIG. 11 display options loop, by enabling the vehicle motion display option while disabling the alternative option which favors the display of facilities and attractions surrounding the user's current position. But, whenever the user and CAMLS GPS PDA stop or slow down below a preset speed, then the proposed subprogram proceeds to readjust the option selector 215 automatically. More particularly, the subprogram switches between alternative routines on the programmable list of display options as implemented by the options loop, illustrated in FIG. 11 at 415, 417, 421 and 423. As a result, while at rest or slow speed mode, the display

shifts away from information on vehicle position, speed and travel direction in order to look around at surrounding hotels, restaurants and the like.

Detailed Description Paragraph Right (166):
In summary, while the user is driving along at travelling speed, the PDA focuses on the road ahead and the motion of the vehicle. However, when the user stops or slows down, then the PDA display is preprogrammed to readjust itself and display more information on local facilities and attractions including campgrounds, shops, tourist attractions, parks, hospitals, police stations, etc. As soon as the user returns to her car, however as a result of starting to move or achieving a preset speed, the subprogram readjusts the display options again such that the GPS PDA map display resumes its concentration on vehicle motion and road ahead information.

Detailed Description Paragraph Right (167):
TABLE V illustrates an example of a primary menu for the Display/Output Options available through the optional display routines listed in TABLE IV and the mapping display subsystem flow chart illustrated in FIG. 11. The main menu of TABLE V permits user selection among a number of submenus or subsidiary menus, three of which are shown by way of example in TABLES VI, VII, and VIII. The subsidiary menus shown by way of example in TABLES VI-VIII are selected from the main menu using a menu bar, entering commands on the keyboard, clicking on icons, etc. Some sub-submenus may also be provided, selected similarly from the subsidiary submenus of TABLES VI-VIII.

Detailed Description Paragraph Right (168):
In the examples of TABLES V-VIII, the submenu of TABLE VI is selected from the main menu of TABLE V by placing the menu bar over "5) MAPPING OVERLAYS" and pressing a key, entering a command, or clicking with a mouse at the appropriate icon or location. The submenu of TABLE VI provides a selection of the available mapping overlays for supplementing the display of a selected grid quadrangle. The submenu of TABLE VII is selected from the main menu by placing the menu bar over the selection "8) GPS DISPLAY/OUTPUT" and pressing a key, entering the appropriate command, or mouse clicking, etc. The submenu of TABLE VIII is selected from the main menu by placing the menu bar over "6) SEQUENCES/SCRIPTS" and pressing a key, entering the appropriate command, mouse clicking, etc. The submenu of TABLE VIII provides a selection of the travelogs and travel information available for a selected route.

Detailed Description Paragraph Right (170):
FIG. 15B illustrates MAPPING OVERLAYS of four of these selections from the submenu of TABLE VI including "EATING PLACES", "PLACES TO STAY", "PUBLIC SAFETY", and "PUBLIC PARKS". These overlays selected from the menu of TABLE VI are displayed against a simple road network background. The user can readily switch or toggle between the two alternative digital overlays illustrated by FIGS. 15A and 15B. The user can also readily print out a hardcopy of the maps illustrated in FIGS. 15A and 15B. In each of the examples of FIGS. 15A and 15B, the user cross references, coordinates, and correlates the display of the unique grid quadrangle US-SW-C4-B2-D1 with the corresponding grid quadrangle of a CAMLS printed map for reference to other surface features and mapping features.

Detailed Description Paragraph Right (171):
FIG. 15C illustrates the selection "DOT-IN-A-BOX" from the submenu for GPS DISPLAY/OUTPUT of TABLE VII. FIG. 15C provides a simple indication by means of a dot of the location of a user with a GPS sensor in the unique grid quadrangle with the grid name US-NE-B1-D5. FIG. 15D illustrates the result of selection of the submenu entries "TRAVEL DIRECTION", "CURRENT SPEED", "BREADCRUMBS", and "ALTITUDE/ELEVATION" from the submenu for GPS DISPLAY/OUTPUT of TABLE VII. Travel direction is indicated by direction of the arrow, current speed is indicated by the length of the arrow, the "breadcrumbs" or dots illustrate the previous path of the user, and altitude/elevation is indicated in a box accompanying the arrow. In each of the examples of FIGS. 15C and 15D the user coordinates and correlates the display of the unique grid quadrangle US-NE-B1-D5 with the corresponding grid quadrangle of a printed CAMLS map for reference to surface features and mapping features shown in greater detail on the printed map. The user can also switch or toggle between FIGS. 15C and 15D as alternative digital display formats. Hardcopies of the respective displays illustrated in FIGS. 15C and 15D can also be printed from an available printer. The CAMLS software can be programmed to switch automatically between the displays of FIGS. 15C and 15D

for example according to whether the user or the user's vehicle is moving or at rest. Such an operation uses step 463 of the routines listed in TABLE IV.

Detailed Description Paragraph Right (172):
FIGS. 15E and 15F illustrate alternative digital displays for the unique grid quadrangle US-SW-C4-B2-D1 selected from the menu entries "ROAD EYES AND EARS" and "LOOK ABOUT" from the submenu GPS DISPLAY OUTPUT of TABLE II. As shown in FIG. 15E the selection "ROAD EYES AND EARS" focuses on critical driving information along the road ahead giving speed, travel direction and position with reference to identified roads for driving. On the other hand FIG. 15F shows user vehicle location only by a simple blinking dot when the user vehicle is at rest. The "LOOK ABOUT" selection then focuses on items of interest in the surrounding area such as restaurants, motels, parks, etc. A subprogram of the DISPLAY/OUTPUT OPTIONS can automatically switch between the displays of FIGS. 15E and 15F according to whether the user's vehicle is in motion or at rest. In either instance the user can coordinate and correlate the displays illustrated in FIGS. 15E and 15F with the correspond grid quadrangle US-SW-C4-B2-D11 of a CAMLS printed map which may show greater or lesser detail of the surrounding area and other mapping features.

Detailed Description Paragraph Right (173):
FIG. 15G illustrates the capability for display of groups of maps accessed through the submenu selections "GRIDS ON ROUTE" and "MAP SERIES" from the submenu for SEQUENCES/SCRIPTS shown in TABLE VIII. This capability of effectively selecting a travelog with substantive travel information along a proposed route relates to steps 457 and 465 of TABLE IV. FIG. 15G illustrates a stack of maps representing a collection of grid quadrangles, windows or tiles along a selected route. The composition and script for such a map sequence is therefore composed by the user selecting and delineating a route. Such map sequences and series can be organized into complex travel scenarios for education, entertainment, travel, research and planning. Such map sequences and scripts can be implemented by digital display or by print media hardcopy etc. Text, and voice or audio outputs, videos and animations can supplement the graphic display and for some aspects text and audio can substitute for the graphic display.

Detailed Description Paragraph Right (175):
An alternative embodiment meters or measures the extent or duration of the end user's usage of the selected optional other geographic data conversion routines for purposes of assessing a usage fee. Metering can be done remotely when communications links are involved in the downloading of supplemental functions or map data. Internal metering on stand alone devices consists of some digital accounting and reporting subprogram for tracking the extent or duration of usage accessed by a key password or code. With respect to the objectives of interoperability and communications, these features of the CAMLS invention permit switching on and off optional CAMLS capabilities in the field, along with metering or accounting for the duration or extent of usage.

Detailed Description Paragraph Right (176):
As shown in FIG. 9, another point of access or gateway for remote control, for keys and for metering usage inheres in steps 109, 119 and 129. These steps work to initiate or bypass i.e. enable or disable typing operations ultimately determinative of whether raw data packets of certain types are incorporated into CAMLS software and its standard data structures. Also, at step 105, a critical identification is made of the origin of each raw data packet or input event without which all further data processing or display within the CAMLS software would be largely impossible. Step 105, therefore also has potential as a lock requiring some form of key. Moreover, Step 105 forms a gateway at which inputs from particular input devices can be metered as well as enabled and disabled, for implementing a "fee for service" information distribution and support system.

Detailed Description Paragraph Right (180):
According to various alternative embodiments of the invention, reference is made to FIGS. 1-3. In each of the embodiments of FIGS. 1-3 a personal digital assistant PDA 15 incorporates a digital computer dimension in association with a printed map 14 and atlas 10. According to one alternative embodiment, the PDA 15 can be constructed with a transparent or "see through" screen 18. Such a see through screen is available for example from Bosch Telecom of Germany under the trademark TELDIX (TM). In the

preferred alternative embodiment the dimensions of the transparent screen 18 coincide with the dimensions of the grid quadrangles of the grid printed over the printed map 14. Grid quadrangles displayed on the screen 18 of PDA 15 therefore coincide in dimensions with the grid quadrangles of the printed map 14. With the see through screen, PDA 15 can be placed directly on the printed map 14. The grid quadrangle on display 18 can be aligned with the corresponding grid quadrangle on printed map 14 identified by unique name on the alphanumeric line display shown variously in FIGS. 1, 1C, 2, 3, and 3A. By this physical arrangement, the display of the location 28 of a loc/object or user location on the PDA screen 18 can be precisely correlated with a location on the corresponding grid quadrangle of the printed map 14.

Detailed Description Paragraph Right (181):
According to another alternative embodiment, the graphic screen display 18 of the PDA 15 may not be used at all or may be replaced with a speaker for voice output. According to this alternative embodiment, the outputs provided by PDA 15 are a voice output sounding the name of a uniquely named grid quadrangle or an alphanumeric line display or text line display setting forth the unique name of an identified grid quadrangle as shown by way of example in FIGS. 1, 1C, 2, 3, and 3A. Step 445 provides text display or voice output of related information.

Detailed Description Paragraph Right (182):
Thus the user might enter a query in PDA 15 "Where is Freeport, Me.?" or "Where is the Blue Onion Restaurant?". In response to this query the PDA 15 addresses the appropriate database, available, for example on PCMCIA cards or other database sources on memory devices, wired data links, or wireless data links and identifies the pertinent grid quadrangle at the PDA computer outputs. The unique name of the grid quadrangle is sounded by the voice output or displayed on the alphanumeric line display. Referring to the corresponding grid quadrangle on the printed map 14, the location of Freeport, Maine can be readily identified. With respect to the Blue Onion Restaurant, additional queries may be posed by the user operating within the selected grid quadrangle to obtain address location, current specials for the day, and other pertinent information afforded the traveler.

Detailed Description Paragraph Right (183):
As previously noted the printed maps may take the form not only of paper maps and other sheet media presentations, but also projections from the printed map or other sheet media. For example, a wall map can be provided at an enlarged scale by suitable projection optics, for example for tracking fleets of vehicles. According to another example as shown in FIG. 13, an enlarged printed map 80 on paper, transparent sheet, or other light transmissive medium can be back lighted by a light box 82 covering the area of the map 80. The enlarged translucent map 80 represents the printed map or other fixed media component of the system. The light box 82 is divided into separate light compartments 84 each with its own light source 85 controlled by the back light controller 251 and analog output interface 250 previously shown in FIG. 7. Selective back lighting or illumination can be used to highlight a relevant or selected grid quadrangle for example for tracking a vehicle of a fleet of vehicles. A smaller back lighted map book 88 is also shown. Step 447 of TABLE IV provides the analog or projected outputs.

Detailed Description Paragraph Right (184):
A communications application of the CAMLS system for an accident location and response system is illustrated in FIGS. 14A-14D. As shown in FIG. 14A an in-vehicle alarm system 90 is actuated by the accident impact of vehicle 92. The in-vehicle alarm system 90 can be actuated e.g. by means of an airbag type sensor. The alarm system transmits GPS type position data along with an emergency signal indication to a central dispatch office 94 illustrated in FIG. 14B. This is an example of the optional display routines set forth in steps 449 & 459 of TABLE IV.

Detailed Description Paragraph Right (185):
The central dispatch office 94 receives the emergency signal and displays location of the accident based on transmitted GPS data on a desktop monitor 95 and on a backlighted wall map 80 of the type illustrated in FIG. 13. The central office can of course make a hardcopy from a printer for record keeping purposes or for circulation. The central dispatch 94 also transmits the accident location data to a tow truck equipped with a CAMLS pager type receiver 96 illustrated in FIG. 14C, an example of

step 445 of TABLE IV. Alternatively the tow truck may incorporate an in-vehicle FAX machine for downloading a map of the accident scene.

Detailed Description Paragraph Right (186):
The tow truck pager 96 receives the accident location data and displays it in the form of extended text and name along with characterization of the emergency. The tow truck operator uses the extended grid quadrangle name with a CAMLS printed map 98 to ascertain the location of the accident.

Detailed Description Paragraph Right (187):
According to an alternative embodiment illustrated in FIG. 14D a police officer or other witness to the accident uses a CAMLS PDA 100 either with GPS for automatically geocoding the accident location, or without GPS manually geocoding the accident scene. The accident location data is then communicated via wireless communications link such as an FM communications link to the central dispatch office 94 of FIG. 14B. The police officer may at the same time be correlating the grid quadrangle of the accident location shown on the PDA display with a corresponding grid quadrangle of a CAMLS printed map providing additional information about the accident scene.

Detailed Description Paragraph Right (189):
According to a further alternative embodiment illustrated in FIG. 14E the locus of the accident is geocoded by hand by a witness or observer of the accident. The witness or observer 100 marks the locus of the accident with a pen or pencil 102 on a CAMLS printed map 104. The printed map 104 is of course encoded with the grid quadrangles of the CAMLS grid system for identifying the location of the accident by gridname. As shown on the watch of observer 100 the accident location is geocoded by hand with a pen at approximately 3 P.M.

Detailed Description Paragraph Right (190):
Subsequently at 5 P.M. a handheld scanner device 106 is used to digitize the geocoded accident location into a CAMLS computer system such as a desktop computer system 108 equipped with CAMLS software as shown in FIG. 14F. The accident scene and geographical location can then be displayed on the computer display 110, stored in the computer database, and printed out by printer 112 all under the control of the CAMLS software. This is an example of steps 357 and 361, of TABLE I and step 371 of TABLE II.

Detailed Description Paragraph Center (12):
OPTIONAL DISPLAY ROUTINES FIG. 11 STEPS 415, 417, 421, 423

Detailed Description Paragraph Table (1):
TABLE V ______________________________________ DISPLAY/OUTPUT MAIN MENU DISPLAY/OUTPUT OPTIONS ______________________________________ 1) TEXT DISPLAYS 2) HARDCOPY OUTPUT 3) ANALOG INTERFACE 4) LOCATED OPERATIONS 5) MAPPING OVERLAYS 6) SEQUENCES/SCRIPTS 7) ROUTES AND LINES 8) GPS DISPLAY/OUTPUT 9) TRAVEL INFO

____

Detailed Description Paragraph Table (3):
TABLE VII ______________________________________ POSITION SENSOR SUBMENU #8 8) GPS DISPLAY/OUTPUT ______________________________________ DOT-IN-A-BOX TRAVEL DIRECTION CURRENT SPEED BREADCRUMBS LOCATED MESSAGES LOCATED FUNCTIONS ALTITUDE/ELEVATION ROAD-EYES & EARS LOOK-ABOUT ______________________________________

Detailed Description Paragraph Table (4):
TABLE VIII ______________________________________ MAP/GRID LISTS SUBMENU #6 6) SEQUENCES/SCRIPTS ______________________________________ SEQUENCE OVERLAYS GRIDS EN ROUTE MAP SERIES COMPARE PLACES CROW FLIGHTS SIGHTS & SOUNDS FACTS & FIGURES LOCAL HISTORY TAKE A HIKE ______________________________________

CLAIMS:

1. A computer aided map location system (CAMLS) for assisting a user in map reading and map use comprising:

at least one printed map corresponding to a selected geographical area, said printed map depicting surface features at a particular level of detail, said printed map

comprising grid lines substantially parallel with coordinate lines of a selected geographical coordinate system, said grid lines defining boundary lines of printed map grid quadrangles identified by printed map grid quadrangle names;

a first computer means having a display, said first computer means being programmed to display on said display selected display grid quadrangles identified by first display grid quadrangle names corresponding to said printed map grid quadrangle names;

at least one database of selected geographical-coordinate-locatable objects (loc/objects) storable on a memory device and readable by said first computer means, said selected loc/objects identified by geographical coordinate location in said selected geographical coordinate system, said first computer means being programmed to display on said display locations of one or more of said selected loc/objects in said display grid quadrangles corresponding to map locations of said selected loc/objects in said printed map grid quadrangles of said printed map;

a second computer means having an output programmed to indicate second grid quadrangles names for user correlation with corresponding printed map grid quadrangles.

2. The CAMLS as claimed in claim 1 wherein said second computer means includes a second display, said second computer means being programmed to display on said second display selected grid quadrangles identified by said second display grid quadrangle names for user correlation with corresponding printed map grid quadrangles;

and a data communications link between said first computer means and said second computer means.

5. The CAMLS as claimed in claim 4 wherein said locating means is a Global Positioning System (GPS) receiver.

6. A computer aided map location system (CAMLS) comprising:

a first set of printed maps corresponding to selected geographical areas, said first set of printed maps depicting surface features at a particular level of detail, said first set of printed maps substantially coinciding in geographic area with grid quadrangles of a first set of printed map grid quadrangles of substantially equal area and substantially constant scale, said first set of printed map grid quadrangles having boundary lines substantially parallel with coordinate lines of a selected geographical coordinate system and forming a first-level printed map grid, said first set of printed map grid quadrangles being identified by first printed map grid quadrangle names;

said first set of printed maps being subdivided into a second set of printed map grid quadrangles of substantially equal area and constant scale by a second level grid, wherein each grid quadrangle of said second set of printed map grid quadrangles covers a smaller geographical area than said grid quadrangles of said first set of printed map grid quadrangles, said second set of printed map grid quadrangles being defined by boundary lines substantially parallel with coordinate lines of said selected geographical coordinate system and being identified by second printed map grid quadrangle names;

first computer means having a display, said first computer means being programmed to display on said display selected display grid quadrangles corresponding to said first set of printed map grid quadrangles and to said second set of printed map grid quadrangles identified by display grid quadrangle names;

at least one database of selected geographical-coordinate-locatable objects (loc/objects) storable on a memory device and readable by said computer means, said selected loc/objects identified by geographical coordinate location, said first computer means being programmed to display on said display locations of one or more of said selected loc/objects in said display grid quadrangles corresponding to map locations of said selected loc/objects in said first set of printed map grid quadrangles and said second set of printed map grid quadrangles;

a second computer means at a location remote from said first computer means, said second computer means being programmed in a manner similar to said first computer means;

and a data communications link between said first computer means and said second computer means.

7. A computer aided map location system (CAMLS) comprising:

a first set of substantially constant-scale printed maps at a first scale depicting surface features over a specified geographical area, over a specified geographical area, said first set of substantially constant-scale printed maps substantially coinciding with substantially equal-area first printed map grid quadrangles of a first scale grid, said first printed map grid quadrangles being identified by a first set of printed map grid quadrangle names;

a first computer means having a display, a first database, and a display subsystem performing functions of a database manager, said first database comprising said first set of printed map grid quadrangle names;

said first scale grid comprising grid lines defining boundary lines of said first set of grid quadrangles, said boundary lines of said first scale grid being substantially parallel to lines of latitude and longitude across said specified geographic area and being identified in said first database by latitude and longitude location;

said display subsystem being constructed to cause the drawing and display of selected printed map grid quadrangles of said first scale grid as a first set of display grid quadrangles identified by a first set of display grid quadrangle names, said display grid quadrangles being correlated with printed maps from said first set of printed maps substantially coinciding in geographic area with said selected printed map grid quadrangles;

said first computer means comprising a user location system for generating signals corresponding to the latitude and longitude of a location of a CAMLS user, and wherein said display subsystem is constructed for displaying on said first computer means display said location of said CAMLS user on selected display grid quadrangles displayed on said display for correlation of locations with said printed maps of said first set of printed maps coinciding in geographic area with said selected printed map grid quadrangles;

said first set of printed maps comprising a second scale grid formed on said first set of printed maps subdividing each of said printed map grid quadrangles of said first scale grid into a plurality of substantially equal area second scale second printed map grid quadrangles identified by a second set of printed map grid quadrangle names, said second scale grid comprising grid lines defining boundary lines of said second set of printed map grid quadrangles, said boundary lines of said second scale printed map grid quadrangles being substantially parallel to lines of latitude and longitude across said specified geographic area; and

said first database comprising said second set of printed map grid quadrangle names, said boundaries of said second printed map grid quadrangles being identified by latitude and longitude in said first database, said display subsystem being constructed for drawing and displaying on said display of said first computer means boundary lines of selected grid quadrangles of said second scale grid identified by unique name and for displaying the location of a CAMLS user on the second printed map grid quadrangles for correlation of locations with printed maps of said first set of printed maps with greater localization;

a second set of substantially constant scale maps at said second scale depicting surface features in greater detail than in said first set of printed maps over said specified geographical area, said second set of printed maps substantially coinciding in geographic area with grid quadrangles of said second scale grid for correlating said location and a route of said CAMLS user displayed on a second display grid quadrangle with locations on a coinciding printed map of said second set of printed maps; and

a second database storable on a memory device and readable by said first computer means comprising latitude and longitude locatable objects (loc/objects) identified by latitude and longitude location in said specified geographical area, said display subsystem causing selected loc/objects to be displayed in displayed grid quadrangles of said first scale grid or said second scale grid for correlation with locations on said printed map of said first set of printed maps or said second set of printed maps coinciding in geographic area with said specified printed map grid quadrangles;

a second computer means;

and a data communications link between said first computer means and said second computer means.

8. A computer aided map location system (CAMLS) for assisting a user in reading and using a printed map comprising:

at least one printed map corresponding to a selected geographical area, said printed map depicting surface features at a desired level of detail, said printed map comprising grid lines substantially parallel with coordinate lines of a selected geographical coordinate system, said grid lines defining boundary lines of printed map grid quadrangles identified by printed map grid quadrangle names;

a first computer means having an output, said first computer means being programmed to identify selected grid quadrangles by selected grid quadrangle names at said output for correlation by a system user with said printed map grid quadrangles;

and at least one database storable on a memory device and readable by said first computer means, said database including selected geographical coordinate locatable objects (loc/objects) identified by geographical coordinate location, said first computer means being programmed to transmit grid quadrangle names of grid quadrangle locations of one or more specific selected loc/objects in response to user queries for user correlation with said printed map grid quadrangles;

a second computer means at a location remote from said first computer means, said second computer means comprising at least one database of information about loc/objects;

and a data communications link between said first computer means and said second computer means.

10. A computer aided map location system (CAMLS) for assisting a user in map reading and map use comprising:

a first computer means having a display, said first computer means being programmed to display on said display selected display grid quadrangles identified by first display grid quadrangle names;

at least one database of selected geographical-coordinate-locatable objects (loc/objects) storable on a memory device and readable by said first computer means, said selected loc/objects identified by geographical coordinate location in said selected geographical coordinate system, said first computer means being programmed to display on said display locations of one or more of said selected loc/objects in said display grid quadrangles;

a second computer means having an output programmed to indicate second grid quadrangles names for user correlation with corresponding first display grid quadrangle names.

11. The CAMLS as claimed in claim 10 further comprising at least one printed map corresponding to a selected geographical area, said printed map depicting surface features at a particular level of detail, said printed map comprising grid lines substantially parallel with coordinate lines of a selected geographical coordinate system, said grid lines defining boundary lines of printed map grid quadrangles identified by printed map grid quadrangle names corresponding to said first display

grid quadrangle names.

14. The CAMLS as claimed in claim 13 wherein said data communications link permits a CAMLS user to obtain information regarding said loc/objects and waypoints and to relate positions of said loc/objects and said waypoints to said display grid quadrangles.

16. The CAMLS as claimed in claim 15 wherein said locating means is a Global Positioning System (GPS) receiver.

19. The CAMLS as claimed in claim 17 further comprising at least one printed map corresponding to a selected geographical area, said printed map depicting surface features at a particular level of detail, said printed map comprising grid lines substantially parallel with coordinate lines of a selected geographical coordinate system, said grid lines defining boundary lines of printed map grid quadrangles identified by printed map grid quadrangle names corresponding to said first display grid quadrangle names.

WEST

Generate Collection Print

L11: Entry 48 of 86 File: USPT Oct 13, 1998

DOCUMENT-IDENTIFIER: US 5821880 A
TITLE: Vehicle route guidance apparatus for researching for a route when vehicle goes out of route

Abstract Paragraph Left (1):
A route guidance section compares the current position provided by a current position determination section and the route provided by a route calculation section for detecting an off-route condition. When the off-route condition is detected, a re-searching key as well as the route and current place is displayed on a display section. When the re-searching key is touched, a search is again made for a new route from the current position to the destination. Then, route guidance is again started in response to the re-searching result. When the re-searching key is not touched, the route and current place continue to be displayed while the vehicle carrying the apparatus travles off route, thereby efficiently preventing the apparatus from executing unnecessary re-searching when the driver drives the vehicle off route on purpose.

Brief Summary Paragraph Right (4):
Various types of apparatus to relieve drivers of their work load have been designed and are carried by vehicles. One of them is a route guidance apparatus for guiding the user through a route to a destination. A route guidance apparatus, which has a function of informing the driver of routing, when the vehicle passes a branch point such as a crossing, for guiding the driver through the route with a generated voice is known. Such an apparatus it is disclosed, for example, in Japanese Patent Laid-Open No.Hei 1-173815.

Brief Summary Paragraph Right (5):
When a destination is entered, the route guidance apparatus can search for a route from the current place to the destination and then display the found route for the driver. It also has a function of detecting the current position of the vehicle. When the vehicle moves, the route guidance apparatus displays both the route and the current position for guiding the driver through the route.

Brief Summary Paragraph Right (6):
Although the driver is guided through the route, the vehicle may stray off the predetermined route. In such a case, the driver might want to know a new route from the current place to the destination. Proposed in Japanese Patent Laid-Open No.Hei 1-173815 is an apparatus which, when the vehicle goes off the preset route, alerts the driver and re-searches for a new route to the destination.

Brief Summary Paragraph Right (7):
The route guidance apparatus enables the driver to obtain preferred guidance through a new route from the current place to the destination even if the vehicle goes off the route.

Brief Summary Paragraph Right (8):
However, when the driver is on the way to the destination, they may place the vehicle off the route on purpose, perhaps in order to do some shopping at a store along the road or to, pick up a person on the assumption that the driver will return the vehicle to the predetermined route. Even in such a case, the conventional apparatus automatically re-searches for a route. Further, if the driver returns the vehicle to the original route by taking a different route from the re-searching result, the

apparatus repeats. While re-searching is being executed, guidance stops. Unnecessary re-searching is performed and the operation of the apparatus does not meet the user's needs.

Brief Summary Paragraph Right (9):
Accordingly, it is an object of the invention to provide a vehicle route guidance apparatus which can efficiently re-search for a new route when the vehicle carrying the apparatus goes off the old route to a destination.

Brief Summary Paragraph Right (10):
To this end, according to one embodiment of the invention, there is provided a vehicle route guidance apparatus which searches for a route to a destination and executes route guidance at a branch point or the like, comprising:

Brief Summary Paragraph Right (12):
Preferably, the route guidance apparatus further includes means for displaying the route and the current position on a map to enable the user to easily recognize the route.

Brief Summary Paragraph Right (13):
Preferably, the display means displays the selected route in a different color from that of other roads.

Brief Summary Paragraph Right (14):
Preferably, the re-searching switch is a touch switch displayed on the display means.

Brief Summary Paragraph Right (16):
Preferably, the re-searching switch is displayed when an off-route condition is detected by the off-route condition detection means. By displaying the re-searching switch and the current position when the off-route condition is detected, the driver can be informed that the vehicle has gone off the route.

Brief Summary Paragraph Type 1 (1):
means for detecting the current position of the vehicle carrying the apparatus;

Brief Summary Paragraph Type 1 (2):
means for comparing the current position and the found route;

Brief Summary Paragraph Type 1 (5):
means for again searching for a new route from the current position to the destination;

Drawing Description Paragraph Right (3):
FIG. 2 is an illustration showing a display example of route guidance;

Drawing Description Paragraph Right (4):
FIG. 3 is an illustration showing a display example of route guidance around a crossing;

Drawing Description Paragraph Right (5):
FIG. 4 is an illustration showing a display example when an off-route condition is detected;

Drawing Description Paragraph Right (7):
FIG. 6 is an illustration showing display screens when a scale is changed;

Drawing Description Paragraph Right (9):
FIG. 8 is an illustration showing frame display when a detail map is displayed;

Drawing Description Paragraph Right (10):
FIG. 9 is an illustration showing frame display when a global map is displayed;

Drawing Description Paragraph Right (11):
FIG. 10 is a flowchart showing an operation of drawing all route maps;

Drawing Description Paragraph Right (12):
FIG. 11 is a block diagram showing the configuration for screen display;

Drawing Description Paragraph Right (13):
FIG. 12 is an illustration showing the map data contents;

Drawing Description Paragraph Right (18):
FIG. 17 is an Illustration showing the display state when a route is displayed;

Drawing Description Paragraph Right (19):
FIG. 18 is an illustration showing the display state when no route is displayed;

Drawing Description Paragraph Right (21):
FIG. 20 shows one example of a screen display when a place is registered in the fourth embodiment;

Drawing Description Paragraph Right (22):
FIG. 21 shows another example of a screen display when a place is registered in the fourth embodiment;

Drawing Description Paragraph Right (26):
FIG. 25 shows one display screen example in the fifth embodiment;

Drawing Description Paragraph Right (27):
FIG. 26 shows another display screen example in the fifth embodiment;

Drawing Description Paragraph Right (28):
FIG. 27 shows another display screen example in the fifth embodiment;

Drawing Description Paragraph Right (30):
FIG. 29 is a flowchart of GPS bearing adoption in the sixth embodiment; and

Detailed Description Paragraph Right (2):
FIG. 1 shows a block diagram showing the configuration of a route guidance apparatus according to the invention. Numeral 10 is a map information storage section which stores information such as roads, place names (crossing names), building names, and river names; the stored map information can be read as required. Numeral 14 is a GPS receiver using the Global Positioning System (GPS), which is a satellite navigation system for determining the current position of the vehicle carrying the apparatus. Numeral 16 is a bearing sensor 16 which detects the movement direction of the vehicle in response to terrestrial magnetism. Numeral 17 is a distance sensor which detects the traveling distance in response to the number of wheel revolutions. Numeral 12 is a current position determination section which determines the current position of the vehicle in response to the detection results of the sensors 16 and 17. Information from a steering sensor 19 is also entered, and is used for map matching for correcting the current place to the crossing position on the map when the driver turns the vehicle to the right or left at a crossing.

Detailed Description Paragraph Right (3):
For the route guidance apparatus to guide the driver through a route to a destination, the user should specify the destination on a display section screen (described below) through an input section 18 or enter information such as a place name. A route to the destination from the current position calculated by the current position determination section 12 is calculated by a route calculation section 22 contained in an operation control section 20, and the calculated route is stored in a route storage section 24. An appropriate route search method is adopted for calculating the route.

Detailed Description Paragraph Right (4):
After the destination is entered and the route is determined, actual route guidance is executed. A route guidance section 26 contained in the operation control section 20 reads map information around the vehicle from the map information storage section 10, and displays it together with the current vehicle position and movement direction and the route stored in the route storage section 24 on the display section 28.

Detailed Description Paragraph Right (5):

Display on the display section 28 is controlled by a display control section 29 in the operation control section 20. The display control section 29 has a read-only memory (ROM) which stores patterns of characters, symbols, etc., and an image memory which stores display data for one screen; it uses the memories for controlling the display.

Detailed Description Paragraph Right (6):
The display section 28 is located in an instrument panel near the driver's seat. Seeing the display section 28, the driver checks the position of the vehicle and gets information on the forward route. FIG. 2 shows an example of display on the display section 28. In FIG. 2, the selected route is indicated by a thick solid line 100 and other roads are indicated by thin solid lines 102. The position of the vehicle is indicated by a circle 104 and the movement direction is indicated by a wedge-shaped arrow 106. Displayed roads can be distinguished from each other in colors as well as by line thickness.

Detailed Description Paragraph Right (7):
When the position of the vehicle approaches a crossing 108 where the course is to be changed, the display screen changes to that as shown in FIG. 3, and crossing name 110 and distance 112 to the crossing are displayed. At the same time as the display change, the route guidance section 26 instructs a voice control section 30 to generate a voice corresponding to route guidance at the crossing. The voice control section 30 reads information stored in a voice storage section 32 as digital data and converts it into analog signals for driving a loudspeaker section 34. The voice control section 32 tells the driver a message such as "at the * * * crossing, about 300 m ahead, turn to the left" through the loudspeaker section 34 for route guidance. The voice instruction is given every predetermined distance until the vehicle passes through the crossing. For example, when the vehicle proceeds along on a road of two or more lanes, the first guidance is given 700 m short of the crossing, the second 300 m short of the crossing, and the final guidance 100 m short of the crossing. The guidance voice is stored in a voice storage section 32 as digital data for each phrase. To output a guidance voice, a number of digital data pieces a re read for phrase synthesis. Then, the guidance voice is output from the loudspeaker section 34 as guidance signals. The guidance voice output timing is detected by the route guidance section 26 and processing for the voice output is performed by the voice control section 30.

Detailed Description Paragraph Right (9):
In the embodiment, the display section 28 uses a touch panel as its screen which also functions as the input section. The touch panel enables the driver to enter data simply by touching entries such as a place name displayed on the display section 28. The input section 18 is provided with a menu key 18a to return to a menu screen for selecting processing such as destination input or volume control, a map key 18b for displaying a map, a current place guidance key 18c to return to a current place display screen or request guidance in the current state, an air conditioning key 18d for displaying an air conditioner control screen, and an audio key 18e for displaying an audio control screen.

Detailed Description Paragraph Right (10):
If the driver selects an erroneous route while driving running the vehicle, the current position goes off the predetermined route. Then, the route guidance section 26 recognizes the off-route condition from the comparison of the current position and route. On the other hand, a screen as shown in FIG. 2 is displayed on the display section 28, and if the current position goes off route, it is displayed at a point away from the route, as shown in FIG. 4.

Detailed Description Paragraph Right (11):
At such a time, the route guidance section 26 displays "RE-SEARCH" on the bottom of the screen as shown in FIG. 4. If the driver touches "RE-SEARCH" on the panel, the route guidance apparatus again searches for a new route from the current place to the destination from the beginning, as described above. Upon completion of the re-searching, the route guidance apparatus again starts route guidance in response to the re-searching result.

Detailed Description Paragraph Right (12):
In the embodiment, when an off-route condition is detected, the route guidance apparatus only informs the driver that the off-route condition has occurred by

displaying the route and the current position and "RE-SEARCH" on the screen without immediately executing re-searching. The route guidance apparatus does not re-search for a new route until the driver touches the RE-SEARCH key. This can efficiently prevent the apparatus from executing unnecessary re-searching when the driver drives the vehicle off route on purpose. Particularly, when re-searching is not executed, the route and the current place are displayed.

Detailed Description Paragraph Right (13):
In the first embodiment, the DETAIL and GLOBAL keys are displayed on the map display screen (current place display screen) as shown in FIG. 2. When the driver touches the DETAIL or GLOBAL key on the current place display screen, processing for changing the scale is performed.

Detailed Description Paragraph Right (14):
The scale change processing is described in conjunction with FIG. 5. First, when the DETAIL or GLOBAL key is touched, whether or not a route is set is determined at step S1. That is, a determination is made as to whether or not the driver sets a destination and route to drive the vehicle. If the route is set, an ALL ROUTE key is drawn at step S2 and GLOBAL and DETAIL keys and a scale bar are also drawn at step S3 for displaying ALL ROUTE, GLOBAL, and DETAIL keys and the scale bar on the map screen as shown in FIG. 6. The scale bar denotes a scale; the current scale is indicated in blue (hatched in FIG. 6) and the next scale to be selected is indicated in green (in black in FIG. 6). Then, the current map scale and selected scale positions are drawn on the scale bar at step S4.

Detailed Description Paragraph Right (15):
At step S5, a wait is made for a touched switch to be detected or until 1.5 seconds elapse. Which of the GLOBAL, DETAIL, and ALL ROUTE keys is touched is determined at steps S6-S9. If the touched key is ALL ROUTE, an all route map is drawn at step 10. If the touched key is GLOBAL or DETAIL, whether or not 1.5 seconds have elapsed after the key was touched is determined at step 11. If 1.5 seconds have elapsed, the scale is defined and a map on the selected scale is drawn at step S12.

Detailed Description Paragraph Right (16):
The GLOBAL and DETAIL keys are displayed on the scale change screen and when either key is touched, the scale is changed. Ten types of scale are available: 1 to 10000, 1 to 20000, 1 to 40000, 1 to 80000, 1 to 100000, 1 to 160000, 1 to 320000, 1 to 640000, 1 to 1280000, 1 to 2560000, and 1 to 5120000. A map screen on one of the scales can be selected by touching the DETAIL or GLOBAL key. Since a wait is made for 1.5 seconds at step S11, the scale is changed in sequence by continuing to press the key, and when a proper scale is selected, touching the key is stopped for defining the select ed scale. In the example, the scale is defined by performing no operation for 1.5 seconds.

Detailed Description Paragraph Right (17):
When the scale is defined, the map on the selected scale is drawn at step S12, as shown in FIG. 7. First, the scale is determined. If it is 1 to 40000 or more, the map on the specified scale is drawn on the screen directly. If the scale is 1 to 10000 or 20000, the corresponding map may not exist, thus whether or not the map on the specified scale exists is determined. If the map on the specified scale exists, it is drawn on the screen directly. On the other hand, if it does not exist, a message of "DETAIL MAP IS NOT FOUND" is displayed, then a map on a scale of 1 to 40000 is drawn on the screen. On the other hand, if the previous scale for the map displayed before the present selection operation is 1 to 40000, the scale remains unchanged, thus the message "DETAIL MAP IS NOT FOUND" is displayed, then the screen returns to the former map on the scale of 1 to 40000.

Detailed Description Paragraph Right (18):
In the second embodiment, when a scale is selected, a frame indicating the scale as well as the scale bar is displayed. When a map on a scale of 1 to 160000 is displayed, if the driver touches the DETAIL key and selects a scale of 1 to 100000, any portion other than the portion to be displayed on the scale of 1 to 100000 is hatched as shown in FIG. 8. On the other hand, when a map on a scale of 1 to 100000 is displayed, if the driver selects a scale of 1 to 160000, the display portion on the current scale of 1 to 10000 in a map on a scale of 1 to 160000 is hatched as shown in FIG. 9. Thus, the

frame size is determined in response to a new scale and the relationship between the current scale and new scale is displayed.

Detailed Description Paragraph Right (19):
Therefore, with reference to the frame display, the user can know which part of the map will be displayed after scale selection, and the user can select any scale efficiently. For example, a map where both the current place and destination are entered can be selected easily.

Detailed Description Paragraph Right (20):
Next, drawing an all route map at step S10 is described in conjunction with FIG. 10. First, destination coordinates (dx, dy) and starting point coordinates (sx, sy) are obtained at step S21. Next, at step S22, from the destination coordinates (dx, dy) and starting point coordinates (sx, sy), the coordinates of a midway point (cx, cy) are found by the following expression:

Detailed Description Paragraph Right (21):
Next, the minimum scale on which both the destination and starting point are entered is found at step 23. That is, max (dx-sx, dy-sy) is found. A map on the scale determined at step S23 is drawn with the coordinates (cx, cy) as the center at step S24. In such a sequence, the all route map containing both the starting point and destination is displayed on the screen.

Detailed Description Paragraph Right (22):
In the second embodiment, the ALL ROUTE key is displayed on the scale change screen. This prevents the ALL ROUTE key from being displayed at the normal time and covering a part of the map display. When the user touches the ALL ROUTE key, an all route map is displayed, enabling the user to display all of the route without touching the GLOBAL and DETAIL keys repeatedly.

Detailed Description Paragraph Right (23):
Further, in the embodiment, the center of map display can be changed by single finger motion. When a map is displayed with the normal current position as the center, if the user touches any desired point of the map, the map display center moves to the touched point. For example, if the user touches the left corner of the screen, a change is made to display the map with the left corner as the center. To smooth such a display change operation as single finger motion, the scale can be changed with any desired point as the map center from the current screen. Thus, map display at any desired position and on any desired scale can be accomplished. Large map information is read from the map information storage section 10 into the operation control section 20 and the storage contents may be used for display change. Operation for a movement of the current place can also be smoothed.

Detailed Description Paragraph Right (24):
On the other hand, if the user touches the CURRENT PLACE GUIDANCE key on the input section 18 on the single finger motion screen described above, the map display on the screen can be restored to that with the current position as the center.

Detailed Description Paragraph Right (25):
Further, in the embodiment, the CURRENT PLACE GUIDANCE key also serves as a voice guidance request key in addition to the function key described above. When a map with the current position as the center is displayed in the route guidance mode, if the user touches the CURRENT PLACE GUIDANCE key, route guidance is executed in a voice at that time. On the main menu, the user can enter "voice guidance off" for route guidance in the embodiment. In this case, voice guidance is turned off and route guidance is executed only on the screen. In this state, if the driver touches the CURRENT PLACE GUIDANCE key, voice guidance is executed in response to the current position (for instance, such voice guidance as "left at turn the * * * crossing about 700 m ahead").

Detailed Description Paragraph Right (26):
When voice guidance is requested, a map with the current position as the center is displayed, and to move to the screen with the current position as the center, the current map should be displayed with the point specified through single finger motion as the center, thus one key can be used for the two functions. Therefore, the number

of keys on the input section 18 can be reduced.

Detailed Description Paragraph Right (27):
As described above, according to the second embodiment, when the scale of a displayed map is changed, a figure is displayed on the screen showing the display range relationship between the current displayed map and a new map after the scale is changed. Therefore, seeing the display showing the relationship, the user can set any proper scale. After seeing the display showing the relationship, if the user can change the center position of a new map after changing the scale, setting the center position is also facilitated.

Detailed Description Paragraph Right (28):
A route guidance apparatus according to a third embodiment of the invention uses a color display, such as a color liquid crystal display, as a display section 28. To make the map display more easily discernible, red is assigned to a national railway, brown to a prefectural highway, blue to a river, white to a background, black to characters, and so forth when using a color display.

Detailed Description Paragraph Right (29):
FIG. 11 shows the configuration of an operation control section 20 for display control. As shown here, it has a display control section 29, a main memory 50, a VRAM 52, and a pallet section 54. The main memory 50 is used for the entire operation of the operation control section 20 and it is composed of DRAM.

Detailed Description Paragraph Right (30):
Display data input to the display control section 29 includes map data stored in the map information storage section 10 and specific display data such as current place display data, search results representing route data to a destination, and touch key display data provided by the current position determination section 12 and route guidance section 26. The display control section 29 receives the display data and converts it into display data for each picture element.

Detailed Description Paragraph Right (31):
As the map data in the map information storage section 10, latitudes (x) and longitudes (y) of national and prefectural highways, etc., are stored as shown in FIG. 12. The data in a given range (given latitude and longitude ranges) is read from the map information storage section 10 into the main memory 50. On the other hand, the operation control section 20 previously stores assignments of color codes to classified map display elements (drawn picture element color table), and assigns color codes conforming to display classification to picture elements according to the color code table shown in FIG. 13. In an example in FIG. 13, color code 3 is assigned to the expressway and city expressway, color code 2 to the national highway, and color code 9 to the background. Therefore, based on the display data stored in the map information storage section 10, display element classification, namely, drawn elements are recognized and color codes are assigned to picture elements according to the drawn elements.

Detailed Description Paragraph Right (32):
The display data for each picture element from the display control section 29 is stored in the VRAM 52 which stores display data for one screen. To display a national highway as shown in (a) of FIG. 14, color codes of the background (9) and the national highway (2) are stored for each picture element, as shown in (b) of FIG. 14.

Detailed Description Paragraph Right (33):
Next, the color codes for each picture element read from the VRAM 52 are converted into RGB data by the pallet section 54, and the RGB data is supplied to the display section 28 on which a map is displayed in colors corresponding to the color codes.

Detailed Description Paragraph Right (34):
The pallet section 54 has the configuration as shown in FIG. 15. In the pallet section 54, the color codes supplied for each picture element are converted into strength data for each of red, blue and green. The display section 28 receives the RGB signals and performs predetermined color display. In the embodiment, two conversion systems (pallets 1 and 2) are provided. With the pallet 1, RGB (f, 7, 9: Red) is assigned to the national highway; with the pallet 2, RGB (c, 8, a: Purple) is assigned to the

national highway.

Detailed Description Paragraph Right (35):
In the embodiment, the display control section 29 controls changing of pallets 1 and 2 depending on whether or not route display is executed. As shown in FIG. 16, the display control section 29 determines whether or not route display is executed from the contents of specific display data at step S1. This determination is easily made by the operation control section 20 based on whether or not a destination is set and the route calculation section 22 finds a route. For no route display, the pallet 1 is selected at step S2; for route display, the pallet 2 is selected at step S3.

Detailed Description Paragraph Right (36):
Thus, the display colors can be changed depending on whether or not a given route is displayed. In the example, for no route display, as shown in FIG. 18, the main roads are displayed in red (in black in FIG. 18) like a normal map display for discernible display. On the other hand, for route display, the route to be selected by the user should be highlighted most. Then, as shown in FIG. 17, the route is displayed in red and the main roads are displayed in purple (hatched in FIG. 17), thereby toning down the display of the main roads and clarifying the route.

Detailed Description Paragraph Right (37):
To change other colors for route display, the following techniques can be used in addition to the example given above:

Detailed Description Paragraph Right (39):
In the embodiment, whether or not a given route is displayed is determined, and in response to the result, the pallets are exchanged to automatically change the display colors. Therefore, regardless of whether or not a given route is displayed, a discernible screen display can be provided.

Detailed Description Paragraph Right (40):
To enter any desired starting point and destination through the input section 18, it is cumbersome to search the national map for the local map or look the places up in the place name index each time. In this case, a route guidance apparatus according to a fourth embodiment of the invention is provided with a registration function for the user to prestore desired places in a storage means and set place names instantly as needed. The registration function is controlled by a route guidance section 26 of the operation control section 20. When the place registration mode is set through the input section 18, map information around a given destination stored in route storage section 24 together with the route search result is read and displayed on the display section 28 to enable the user to register the place around the destination.

Detailed Description Paragraph Right (41):
FIG. 19 shows a process flowchart when a place is registered in the fourth embodiment. First, a menu screen appears on which NATIONAL MAP, CURRENT PLACE, PLACE NAME INDEX, ROUTE INFORMATION, MEMORY PLACE, and REGISTER PLACE are displayed. Then, if the user touches REGISTER PLACE for specification, the screen shown in FIG. 20 is displayed by the route guidance section 26 which controls the display section 28. Entries of PLACE NAME INDEX, DESTINATION PERIPHERY, CURRENT PLACE PERIPHERY, MEMORY PLACE, NATIONAL MAP, and TELEPHONE NUMBER are displayed on the screen as touch switches. The user can select any desired entry by touching it. If the user selects DESTINATION PERIPHERY on the screen, DESTINATION PERIPHERY is detected at step S101 and whether or not a destination is already set is determined at step S102. If no destination is set, a message to the effect that no destination is set is displayed on the screen to prompt the driver to set the destination. On the other hand, if a destination is already set, map information around the destination stored in the route guidance section 24 is read at step S103, and the map with the destination as the center is displayed on the display section 28 at step S104.

Detailed Description Paragraph Right (42):
FIG. 21 shows one example of a map with the destination as the center, wherein "KYOTO CENTURY HOTEL" is the destination, which is indicated by a double circle. The thick line in the figure indicates the route provided as a result of search. The cursor position is indicated by the + symbol. When the user touches any of the arrows pointing in eight directions displayed surrounding the cursor, the map is moved on the

screen at step S106; the user can move the cursor to any desired place. When the user moves the cursor to the place to be registered and touches the SET PLACE switch in the lower left portion of the screen, the coordinates of the place are entered at step S105, and the route guidance section 26 stores the entered place coordinates in the map information storage section 10 for registration at step S107. Then, the place around the destination is registered and can be read as memory location. Thus, to set the place around the destination as a new destination, the user can also read it easily as a memory location for setting.

Detailed Description Paragraph Right (43):
In the embodiment, to register the place around the destination, the map around the destination is directly displayed on the screen on which the user can set the place name to be registered without using the national map or place name index, thereby facilitating the registration operation and remarkably improving the operability of the navigation system.

Detailed Description Paragraph Right (44):
If the driver selects an erroneous route while he or she is driving the vehicle, the current position is placed off the predetermined route. Then, an off-route condition determination section 26a in the route guidance section 26 compares the current position with the route to recognize an off-route condition. On the other hand, a display as shown in FIG. 2 appears on the display section 28. If the current position is placed off route, the current position is displayed at a point away from the route, as shown in FIG. 4.

Detailed Description Paragraph Right (45):
A route guidance apparatus according to a fifth embodiment of the invention is designed for the driver to select either of two search methods if the vehicle carrying the apparatus goes off route. FIG. 22 shows a process flowchart when an off-route condition is detected in the fifth embodiment. First, if an off-route condition is determined, the route guidance section 26 displays a RE-SEARCH switch on the navigation screen at step S101. As mentioned in the description of the first embodiment, the RE-SEARCH display portion on the bottom of the screen in FIG. 4 is the touch switch. By operating the touch switch, the first search is made, that is, a route from the current position to the original route is found. If the driver touches the RE-SEARCH part on the screen (S102), control proceeds to the next step (S103) at which a RE-SEARCH (ALL ROUTE) switch is displayed. The area in which "RE-SEARCH AGAIN TOUCH FOR ALL ROUTE SEARCH" is displayed on the bottom of the screen shown in FIG. 25 is the RE-SEARCH (ALL ROUTE) switch. Whether or not this touch switch is touched is determined at step S104. If it is not touched, a route from the current position to the original route is again found at step S105 as described above (first search). FIG. 23 shows a process flowchart of the first search. First, at step S201, search data around the current position is read from a search information storage section 10a in map information storage section 10. Next, at step S202, a search is made between the current position and the original route by assuming that the shortest point from the current position to the original route is a temporary destination to find a route from the current position to the original route. Whether or not the first search terminates is determined at step S106. If the search terminates, the search result (first route) is displayed on the screen.

Detailed Description Paragraph Right (46):
On the other hand, if the driver again touches the RE-SEARCH switch on the screen in FIG. 25, YES is determined at step S104 and control jumps to step S108 at which re-searching is executed for a route from the current position to the original destination (second search). FIG. 24 shows a process flowchart of the second search. First, at step S301, search data between the current position and the destination is read from the search information storage section 10a in the map information storage section 10. Next, at step S302, a search is made for a new route to the destination by the same method as searching for the original route, such as the Dykstra method. During searching, the screen as shown in FIG. 26 is displayed informing the driver that searching is in progress. When the searching terminates, the route is displayed on the screen at step S109, as shown in FIG. 27 (second route).

Detailed Description Paragraph Right (47):
In the embodiment, when an off-route condition is detected, the route guidance

apparatus only informs the driver that the off-route condition has occurred by displaying the route and the current position and "RE-SEARCH" on the screen without immediately executing re-searching. The route guidance apparatus does not re-search for a new route until the driver touches the RE-SEARCH key. When the driver touches the RE-SEARCH key once, the first search is made, that is, a route from the current position to the original route is found. If the driver again touches the switch, a search is made for a new route from the current position to the destination. This can efficiently prevent the apparatus from executing unnecessary re-searching when the driver drives the vehicle off route on purpose. In addition, route guidance can be executed more in line with the driver's driving taste.

Detailed Description Paragraph Right (49):
For researching, the route guidance apparatus according to the fifth embodiment of the invention enables the driver to select either of the two types of search for returning to the original route from the current position and for finding a new route from the current position to the destination, thereby providing a more diversified and more flexible navigation system matching driver's driving taste.

Detailed Description Paragraph Right (50):
FIG. 28 shows a more detailed block diagram of the configuration for a bearing determination in a sixth embodiment. Both the steering angle from a steering sensor 17 and the difference between the numbers of revolutions of left and right front wheels from a left and right wheel sensor 18 are supplied to bearing change calculation means 12b in a bearing determination section 12a of a current position determination section 12. A bearing change of the vehicle carrying the apparatus is detected from a steering angle change. At low speed, a bearing change of the vehicle is detected from the difference between the numbers of revolutions of the left and right wheels in response to a detection signal from low-speed detection means 13 which is made up of a speed sensor and a comparator and outputs the low-speed detection signal when the speed falls below predetermined speed, for example, 3.5 km/h. The detected bearing change is added to the preceding bearing for estimating the current bearing. On the other hand, the GPS bearing calculated in response to an output from a GPS receiver 14 is also compared with the preceding bearing to correct the current bearing. However, the GPS bearing is not always adopted; it is adopted only in given cases.

Detailed Description Paragraph Right (51):
FIG. 29 shows a flowchart of determination as to whether or not the GPS bearing is to be adopted. First, at step S101, GPS bearing is received through the GPS receiver 14. Next, at step S102, whether or not the vehicle is traveling at a given speed or higher is determined. If the vehicle runs at the given speed or higher, then control proceeds to step S103 at which whether or not the vehicle runs straightforward is determined. If the vehicle travels straightforward at the given speed or higher, a sufficient Doppler effect from by GPS signals is expected. Whether or not the GPS bearing detected by using the Doppler effect is obtained stably is determined at step S104. If the GPS bearing is stable, it is adopted. In other cases, for example, if the vehicle travels at low speed or is turned left or right, precision sufficient for a bearing determination using the Doppler effect cannot be expected, and the GPS bearing is not adopted.

Detailed Description Paragraph Right (52):
By using the preceding bearing and bearing change and the GPS bearing, a detection error of the steering sensor 17 is removed for calculating the current bearing. The current bearing is supplied to bearing switch means 12c in the bearing determination section 12a. The bearing switch means 12c compares the bearing thus calculated with bearing data from a terrestrial magnetism sensor 16 to estimate the current bearing and also compares the bearing with bearing data of the nearest road obtained as a result of map matching for switching to the bearing matching the road bearing, then outputs this as the final bearing (hybrid bearing). A known technique is used for the map matching. For example, if it is determined in response to a signal from the steering sensor 17 that the vehicle has turned left or right at a crossing, the current position is drawn into the crossing on the map for correction. Road bearing data specified by such map matching may be read from the map information storage section 10 such as CD-ROM into the bearing switch means 12c.

Detailed Description Paragraph Right (53):

In the embodiment, in addition to the conventional bearing sensor, the GPS bearing with GPS signals from artificial satellites can be used for more accurate bearing calculation and further the bearing is corrected so as to match the road bearing obtained by map matching to determine the final bearing, thereby enabling extremely precise bearing detection for improvement in reliability of the navigation system.

Detailed Description Paragraph Right (54):
For the route guidance apparatus described above, a determination of the current position of the vehicle carrying the apparatus is an indispensable function. However, an error is contained in the position determination by the GPS, bearing sensor, steering sensor, and distance sensor as described above. If two roads such as an auto road and a general road are located in parallel, higher precision is required for the current position determination means described above to determine which road the vehicle is traveling. Particularly, discrimination between an elevated highway and a road running underneath requires a technology which is difficult to accomplish.

Detailed Description Paragraph Right (56):
The route guidance apparatus according to the seventh embodiment is designed to execute route guidance in a different manner depending on which of an auto road or a general road the vehicle carrying the apparatus travels on. For example, if the vehicle is traveling on a freeway, the route guidance apparatus executes voice guidance saying "descend the XX ramp on the highway" for informing the driver of the next ramp to go down. If the vehicle travles on a general road beneath the highway at this time, the driver should give apposition change command by touching a RE-SEARCH touch switch displayed on the screen of display section 28. If the current road on which the vehicle is traveling differs from the road to which route guidance applies, the driver may touch the RE-SEARCH switch for causing the route calculation section 22 to read information as to whether or not an adjacent road exists from the map information storage section 10. If an adjacent road exists, the route calculation section 22 changes the current position of the vehicle. Then, the route calculation section 22 calculates a new route to the already entered destination from the current position. The subsequent route guidance sequence is as described above. The new calculated route is stored in the route storage section 24, and in response to the stored information and the determination result of the current position determination section 12, the route guidance section 26 executes route guidance using a voice and by displaying a map on the screen.

Detailed Description Paragraph Right (57):
As described above, when the position of the vehicle is changed to the adjacent road, the route guidance apparatus according to the seventh embodiment is designed to again search for a new route. This researching mode is generally provided to calculate a new route if the driver selects an erroneous road and places the vehicle off a predetermined route. The re-searching mode is provided with an additional step of determining whether or not an adjacent road exists; if an adjacent road exists, the current position is changed to the road for re-searching for a new route.

Detailed Description Paragraph Right (58):
The control flow in the embodiment is described in conjunction with FIG. 30. Whether or not the RE-SEARCH switch is touched during route guidance is determined at step S100. Only when the switch is touched, does control proceed to step S101 at which the current position is detected. The current position is a position immediately before the RE-SEARCH switch is touched, and contains data of the road on which the vehicle is traveling. The data for the road on which the vehicle is assumed to be traveling at any time may differ from the actual road on which the vehicle is traveling. Whether or not a road is adjacent to the road at the detected current position is determined at step S102. If the adjacent road exists, the current position is changed to the adjacent road at step S103, thereby matching the road on the data with the actual road on which the vehicle is traveling. Based on the current position data, a new route is calculated at step S104. In response to the new calculated route, route guidance is restarted at step S105.

Detailed Description Paragraph Right (59):
On the other hand, if no adjacent road exists, control jumps to step S104 at which a route is calculated from the current position. This case applies to a case where the vehicle goes off route for some reason and a new route from the position off route to

the destination is calculated.

Detailed Description Paragraph Right (60):
Although a change of the current position to an adjacent road during route guidance is described in the embodiment, display can also be shifted to an adjacent road when no route guidance is executed, that is, when a map around the vehicle and the current position of the vehicle are displayed on the display section. For example, the apparatus is adopted to change the current position if the user touches the RE-SEARCH switch when no route guidance is executed. First, when the RE-SEARCH switch is touched, whether or not an adjacent road exists is determined. If the adjacent road exists, the driver is aurally informed of the current road on which the vehicle is traveling. If no adjacent road exists, control is terminated. If the current road on which the driver is driving the vehicle differs from the road of which the driver is informed aurally, the driver can again touch the RE-SEARCH switch for changing the current position to the adjacent road.

Detailed Description Paragraph Right (61):
In the embodiment, the user is aurally informed of the current road on which the vehicle is traveling, but the current road may be displayed on the screen of the display section.

Detailed Description Paragraph Left (4):
(i) change colors near the route display color to other colors;

Detailed Description Paragraph Left (5):
(ii) color only the route display;

Detailed Description Paragraph Left (6):
(iii) drop the brightness of display as a whole other than the route display; and

Detailed Description Paragraph Left (7):
(iv) make a large difference between the route display portion and other display portions in hue, chroma, and brightness.

CLAIMS:

1. A vehicle navigation system for informing a driver of a vehicle of a current position of the vehicle, comprising:

a current position detector for detecting a current position of the vehicle on a first road;

a map information memory for storing information concerning road positions;

an adjacent road detector for detecting whether a second road adjacent to the first road on which the detected current position of the vehicle is located exists based on the current position of the vehicle detected from the current position detector and road information obtained from the map information storage,

wherein the detection result of the adjacent road detector is used for specifying the current position of the vehicle.

2. The vehicle navigation system as defined in claim 1, wherein information concerning the road on which the detected current position is located is provided to the driver if the adjacent road detector indicates the presence of an adjacent road.

3. The vehicle navigation system as defined in claim 1, further comprising:

a change commander for commanding a change of the current position, wherein the specified current position of the vehicle is changed to a position on the adjacent road if the change commander commands a change of the current position.

4. The vehicle navigation system as defined in claim 3, further comprising:

a route memory that stores a route to a predetermined destination, wherein a new route

to the predetermined destination is searched for if the change commander commands a change of the current position.

5. A vehicle navigation system for providing route guidance along a predetermined route, comprising:

a current position detection means for detecting a current position of the vehicle;

a re-search commanding means for commanding a re-search of a route from the current position to a destination;

an adjacent road detection means for detecting whether a road adjacent to the road on which the detected current position is located exists, responsive to the re-search commanding means issuing a re-search;

a current position changing means for changing a specified current position of the vehicle to a corresponding position on the adjacent road responsive to the adjacent road detecting means detecting the presence of the adjacent road.

6. The vehicle navigation system as defined in claim 5, further comprising:

a re-search means for re-searching a new route from a new current position to the destination, responsive to the current position changing means changing the current position.

7. A vehicle navigation system for informing a driver of a vehicle of the current position of the vehicle, comprising:

a current position detecting means for detecting a current position of the vehicle on a first road;

a current position check commanding means for externally commanding a check concerning the detected current position of the vehicle;

an adjacent road detection means for detecting whether a second road adjacent to the first road on which the detected current position is located exists responsive to the current position check commanding means issuing a check of the detected current position;

a current position information output means for outputting information concerning the first road on which the detected current position is located, responsive to the adjacent road detecting means detecting the presence of the adjacent second road;

wherein the second road detection result is for use in specifying the current position.

8. The vehicle navigation system as defined in claim 7, comprising:

a current position change commanding means, responsive to an external input, for commanding a change of a specified current position of the vehicle after the detected current position information output means outputs the information concerning the first road on which the detected current position is located; and

a current position changing means for changing the specified current position of the vehicle on the first road to a position of the detected adjacent second road responsive to the current position change commanding means commanding a change.

9. The vehicle navigation system as defined in claim 8, wherein the current position check commanding means and the current position changing means are actuated by a single button, and a first actuation of the button provides the current position check and a further actuation of the button after the road information output which follows the current position check provides the current position change.

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DOCUMENT-IDENTIFIER: US 6346938 B1
TITLE: Computer-resident mechanism for manipulating, navigating through and mensurating displayed image of three-dimensional geometric model

Abstract Paragraph Left (1):
An image processing system renders, displays and provides virtual user navigation through multiple size and aspect views of a three-dimensional (3D) geometric model of an object, such as an urban scene. A user interface, such as a mouse or joystick device, is coupled to a digital image processor and is employed to supply image manipulation signals to the digital image processor for manipulating images displayed upon a digital image display device. The digital image display device contains an overview display window that displays the object from a `bird's eye` or map perspective, and an inset display window that displays the object from a `down inside the scene` perspective. In response to user interface-sourced commands, the processor can swap the two image perspectives and/or controllably navigate through the inset image.

Brief Summary Paragraph Right (1):
The present invention relates to digital image processing systems for rendering and displaying views of three-dimensional (3D) geometric models, and is particularly directed to a computer-resident mechanism that enables a system user to view images generated from 3D geometric information, and to use a convenient user interface such as a joystick and a mouse device, to navigate within animated perspective views of the image as displayed on a high-resolution raster display.

Brief Summary Paragraph Right (2):
Conventional image processing systems for generating and displaying three-dimensional models customarily offer the user the ability to conduct a limited degree of navigation through a scene, including walk/drive/fly navigation with a mouse, or through the use of a joystick device. In such applications, navigation is typically constrained to predefined locations, and may or may not employ an interpolation technique to provide smooth motion from a current location to a new location. For an illustration of literature relating to model display and image processing technology, attention may be directed to the Oka et al, U.S. Pat. No. 4,600,200; Pica, U.S. Pat. No. 4,631,691; Andrews et al, U.S. Pat. No. 4,646,075; Bunker et al, U.S. Pat. No. 4,727,365; Mackinlay et al, U.S. Pat. No. 5,276,785; Amano al, U.S. Pat. No. 5,287,093; Robertson al, U.S. Pat. No. 5,359,703; Robertson, U.S. Pat. No. 5,608,850; Robertson, U.S. Pat. No. 5,689,628; and Marrin et al, U.S. Pat. No. 5,808,613.

Brief Summary Paragraph Right (3):
In accordance with the present invention, the constrained capabilities of conventional 3D model display systems, such as those referenced above, are effectively obviated by a new and improved versatility digital image processing system, that is effective to controllably render and display multiple aspect and size views of a three-dimensional (3D) geometric model, such as, but not limited to an urban scene, one of which is a map or `bird's eye` view of the scene, and the other of which displays a relatively close, or `in-scene` view of the 3D model image. By the use of a user interface, such as a joystick or mouse, the user is not only able to toggle between which of the two scene perspectives is displayed as a map view and which is displayed up close for in-scene navigation, but may readily navigate within the virtual world of the in-scene view of the displayed 3D image.

Brief Summary Paragraph Right (4):
For this purpose, the image processing system architecture of the present invention includes a host computer having an associated high resolution display, and one or more associated user interface devices (e.g., mouse and/or joystick), through which the user controls manipulation of and navigation through images generated on the display. To facilitate manipulation of and navigation through a 3D model, such as `street level` movement through an urban scene, the viewing screen of the display is divided into two viewports, which display respectively different magnification views of an image of the 3D model, from points in three-dimensional space that are respectively `down inside` and `away from` the scene.

Brief Summary Paragraph Right (5):
A first or main viewport may comprise a relatively large region of the display screen, while a second or inset viewport may comprise a relatively small region that overlaps or is superimposed on the main viewport portion. As noted above, one of the viewports will display a map or `bird's eye` view of the scene, while the other viewport will display a relatively close, or `in-scene` view of the 3D model image, and the user may toggle between the two scene perspectives. Operation of the user interface produces input parameters that control navigation within the in-scene view of the displayed 3D image.

Brief Summary Paragraph Right (7):
The overview view of a geographic scene is preferably displayed in a fixed (e.g., North-up) orientation, and is rendered as a 3D perspective map view of the virtual world. Navigation within this `far away` plan view is generally limited, and operation of the user interface moves the user location horizontally and vertically in the display, or at a constant altitude within the image. The overview image maintains the user location in the center of the viewport, so that changing the user location will cause the overview image to pan in the direction opposite the user's motion. The user may change the altitude of the overview viewpoint, to provide a magnification and demagnification action, which essentially allows the user to `zoom into` or `zoom out` of the scene.

Brief Summary Paragraph Right (9):
There are two modes of navigation that the user can perform in the in-scene view: 1) joystick mode and 2) mouse mode. In joystick mode, the user moves the joystick handle and operates buttons on the handle to control user location within the virtual 3D world. In mouse mode, the user clicks on a new vantage or `look-from` point, and then an appropriate target or `look-at` point. The look-at point is employed to orient the user as though standing at the new vantage point. To select a new vantage point, the mouse pointer is placed within the main viewport, and the left mouse button is actuated. The new look-at point is selected while the user continues to hold the left mouse button down, and moves the mouse pointer. In both of these steps the mouse pointer is positioned on the actual 3D model displayed in the main viewport.

Brief Summary Paragraph Right (11):
As pointed out above, the user may operate a pushbutton on the user interface to `toggle` between the two scene perspectives displayed by the respective main and inset viewports. The two views are mutually synchronized, so that the viewing cameras move in a coordinated fashion to swap view locations, as the two viewports exchange their respective display roles. The user may toggle between the two views at any time, even during the transition initiated by a previous toggle state change. In this latter case, the motion simply reverses and the viewpoints begin returning to their immediately previous locations. Since the toggling mechanism of the invention cause the two views to be swapped simply and smoothly, user distraction is minimized, so as to facilitate the user retaining a mental picture of his/her location in the virtual world.

Brief Summary Paragraph Right (12):
A principal benefit of this feature of the invention is that it allows a user at street level in an urban scene to readily and easily ascend or rise to a higher vantage point, in order to realize a better sense of location within the scene. This permits the user to ascend fully to the overview map viewpoint, or to rise up just far enough to realize where he/she is, and then immediately return to street level of the virtual 3D image. This feature also provides a convenient mix of close-up,

on-the-street navigation with longer-range navigation. The user on-the-street can `pop up` to the overview viewpoint, roam quickly to a distant part of the scene, and then descend back to street level in the new location. It additionally avoids the problem of having to provide appropriate scale factors to a single navigation model for both close-up and long-range motions, and avoids the distraction of forcing the user to decide when to use one or the other.

Brief Summary Paragraph Right (18):
As an alternative shape the features of the user icon may be incorporated into a more `human`-looking iconic representation, to provide the additional benefit of a familiar scale of reference, that the human user could employ as an additional visual cue, to aid in estimating the sizes of objects within the scene. The user icon may also be employed for navigation under mouse control and for mensuration.

Brief Summary Paragraph Right (19):
When conducting mensuration, dimensions of features within the image viewed by the user in the main viewport can be measured. In this mode, moving the user location/orientation interactively allows the user to select respective proxy vantage and look-at points. During the selection process, a mensuration icon is displayed between the proxy vantage and look-at points. In addition, the display may show parametric values associated with distance between the proxy vantage and look-at points, change in horizontal distance, and change in vertical distance next to the mouse pointer. Upon completion of the proxy viewpoint specification, the user's viewpoint does not change, as when moving to a new location. This allows the user to measure additional features within the displayed 3D image.

Drawing Description Paragraph Right (2):
FIG. 2 shows an example of the manner in which the viewing screen of the display of the system of FIG. 1 may be divided into two different sized viewports displaying respectively different magnification views of a 3D scene;

Drawing Description Paragraph Right (5):
FIG. 5 diagrammatically illustrates the display of overview and in-scene perspectives of an urban scene in respective inset and main viewports of a display;

Drawing Description Paragraph Right (6):
FIG. 6 diagrammatically illustrates a complement viewport display of overview and in-scene perspectives of the urban scene of FIG. 5 in respective main and inset viewports of a display;

Drawing Description Paragraph Right (14):
FIG. 13 shows the details of the subroutine for the place proxy user icon and look-at point start step 1016 of FIG. 10;

Drawing Description Paragraph Right (20):
FIG. 19 shows a dual view display, in which the larger main viewport is displaying the in-scene view, while the inset viewport is displaying the overview view;

Drawing Description Paragraph Right (21):
FIG. 20 shows a toggling/swapping of the dual view display of FIG. 19, in which the larger main viewport is displaying the overview view, while the inset viewport is displaying the in-scene view;

Drawing Description Paragraph Right (22):
FIGS. 21-27 are pictorial in-scene diagrams for illustrating manipulation of an image for changes in viewpoints;

Detailed Description Paragraph Right (1):
Before describing in detail the digital image manipulation and navigation system of the present invention, it should be observed that the invention resides primarily in new and improved functionality of digital image processing application software that is readily executable within a conventional computer hardware system having a high resolution display and standard user interface components, such as joystick and mouse devices, through which the user may gain access to and control the operation of the computer for the desired manipulation of and navigation through displayed images.

Detailed Description Paragraph Right (3):
FIG. 1 diagrammatically illustrates the overall system architecture of an image processing system in accordance with the present invention as comprising a host computer 10 having an associated high resolution display 12 for displaying digital images to a user 14. Also shown in FIG. 1 are a mouse 16 and a joystick 18, through which the user 14 controls manipulation of and navigation through images generated on the display 12.

Detailed Description Paragraph Right (4):
As a non-limiting but preferred embodiment of a system implementation, a suitable example of the computer 10 for executing the image processing mechanism of the invention may comprise a Silicon Graphics O2 desktop workstation running the Irix 6.5.2 operating system. The `viewer` module of the image processing mechanism of the invention, to be described, may employ the standard Unix and X Window application programming interface (API) obtainable from a variety of vendors, such as but not limited to Sun Microsystems Inc., and Silicon Graphics Inc., and `Iris Performer` (Ver. 2.3) 3D visual simulation API, which is also obtainable from Silicon Graphics Inc. The `Iris Performer` API provides the capability to convert a 3D scene described by vertices, polygonal faces described by those vertices, colors, and texture map images into a rasterized projection of the 3D scene. The 3D scenes may be loaded from files containing descriptions in `OpenInventor` description format (available from Silicon Graphics Inc, or Template Graphics, for example). The mouse device 16 may comprise a conventional three-button system mouse, and the joystick 18 may comprise a BG Systems `Flybox`, which connects to a serial port on the workstation.

Detailed Description Paragraph Right (5):
As shown in FIG. 2, the viewing screen 20 of the display 12 is dividable into two rectangular regions or viewports 21 and 22, that are used to display respectively different magnification views of a 3D urban scene from points in three-dimensional space that are relatively near to the scene, so that details of the scene can be observed, and far away from the scene so that a `bird's eye` view of the scene may be maintained. The first or main viewport 21 may comprise a relatively large display region, while the second or inset viewport 22 may comprise a relatively small viewport that overlaps the main viewport. It should be observed, however, that the invention is not restricted to such relative sizes, and the viewports need not overlap. As will be described, one viewport displays an overview or `bird's eye` view of the scene, and the other viewport displays a closer `in-scene` view of the scene. Either of the two viewports 21 and 22 can display either an overview or in-scene view by toggling between views; the user input is defaulted to the main viewport 21. The input is interpreted by whichever view is currently displayed within the main viewport 21. Although not shown as such in the flowcharts to be described below, it may be noted a focus mechanism may be employed to allow either viewport to accept user inputs.

Detailed Description Paragraph Right (6):
In addition, although main viewport 21 is larger than the inset viewport 22, they both have the capability to display the same view of the 3D scene. It is preferred that the two viewports be displayed in close proximity to one another (e.g., on the same screen), in order to provide a single user with additional information via multiple views of the scene. As non-limiting variations, different viewports may be assigned to different collaborating users, and the viewports may be displayed in separate windows on the same display, or on widely separated display devices.

Detailed Description Paragraph Right (7):
As pointed out briefly above, control of the image manipulation and navigation system of the invention is effected by means of the user-operated mouse and joystick input devices 16 and 18, respectively. Both devices are used for different aspects of navigation. For purposes of the present description, only the main viewport 21 receives the user's interactive input from both the mouse and joystick. The three-button mouse 16 provides incremental X and Y displacement values and left, middle, and right button state values. Through software the mouse is sampled periodically and the inputs are made available to the computer as a set of values that can be sampled as needed.

Detailed Description Paragraph Right (9):

FIG. 4 diagrammatically illustrates the various image processing entities of which the system of the invention is comprised, and their roles and relationships relative to each other. User 41 corresponds to a human operator, who controls the system by manipulating (mouse/joystick) input devices 42. When the user 41 manipulates the input devices 42, these devices produce input values or parameters 43 that are used to navigate within the virtual world of a 3D image 44 generated on a display 45. During this operation, the user is effectively changing the 3D location and orientation of a user virtual representation icon 46 within the virtual world of the displayed image.

Detailed Description Paragraph Right (11):
As the user manipulates the image, an interpolation mechanism 51 is controllably accessed to supply control information to a view camera operator 52, outputs of which are coupled to the view 47, and a renderer 53. The renderer 53 is employed to create or draw the 3D scene 44 and to render the view 47, while the view is coupled to a viewport 54, which defines the overview and in-scene presentations of the image to the display 45.

Detailed Description Paragraph Right (12):
One of the two viewports 21 and 22 displays an overview of the scene, while the other viewport displays an in-scene view. As referenced briefly above, the overview view of geographic imagery data, shown in the inset viewport 22 in FIG. 5 and the main viewport 21 in FIG. 6, may comprise a map or plan view of the scene of interest from the perspective of a relatively high altitude directly above the user location 23, which appears in the center of the overview viewport. The overview view of a geographic scene may be presented in a North-up orientation, i.e., with the northerly direction being towards the top of the display, South to the bottom, West to the left, East to the right. The overview orientation serves as an aid in cognition for those who may have studied maps of the geographic area of the scene of interest, and provides a canonical view orientation to which the user can return at any time. Even though such a view is a straight-down map view, it is still rendered as a three dimensional perspective view of the virtual world. Depth (on stereoscopic displays) and perspective foreshortening are discernable for objects of sufficient size and proximity to the viewpoint.

Detailed Description Paragraph Right (13):
Navigation within the overview view is generally limited. The joystick moves the user location horizontally (at a constant altitude) within the virtual world. Twisting the joystick handle changes the azimuth (line-of-sight viewing direction) of the user orientation. This does not rotate the map view; it maintains a North-up orientation, as described above. As further shown in FIG. 7, pushing forward on the joystick handle moves the user location northward relative to the user location in FIGS. 5 and 6. Pulling back on the joystick will move the user location southward; pushing left moves it westward; and pushing right it moves eastward.

Detailed Description Paragraph Right (14):
Because the overview view always keeps the user location in the center of the viewport, changing the user location will cause the map view to pan in the direction opposite the user's motion. The two pushbuttons 36, 37 on the joystick handle 31 change the altitude of the overview viewpoint, to provide a magnification and demagnification action, which essentially allows the user to `zoom into` or `zoom out` of the scene. The pushbuttons 36 and 37 do not modify the user's location within the displayed scene.

Detailed Description Paragraph Right (16):
There are two modes of navigation that the user can perform in the in-scene view: 1) joystick mode and 2) mouse mode. In joystick mode, the user operates the joystick handle 31 to move the user location vertically or horizontally in the display at a constant height above a surface of the virtual world. As pointed out above, for the case of an urban street scene as a non-limiting example, the in-scene view will typically be from near-ground-level. As shown in the in-scene perspective view of FIG. 7, pushing forward on the joystick handle moves the user location forward (in the azimuth direction of the view) along street level, relative to the user location in the in-scene view of FIG. 5.

Detailed Description Paragraph Right (19):

In accordance with the second or mouse mode of navigation, the user location/orientation may be manipulated with the mouse input device 16. In order to choose a location/orientation, the user first selects a new vantage or `look-from` point, and then an appropriate target or `look-at` point. The look-at point is employed to orient the user when standing at the new vantage point. As will be described in detail below, selecting a new vantage point is accomplished by placing the mouse pointer within the main viewport 21, and pressing the left mouse button. The new look-at point is selected while the user continues to hold the left mouse button down, and moves the mouse pointer. In both of these steps the mouse pointer must remain in the main viewport 21 and be located over that portion of the 3D model being displayed (i.e., not up in the sky).

Detailed Description Paragraph Right (20):
In the course of executing the respective steps of the sub-routines (shown in the flow charts of FIGS. 8-17, to be described) through which manipulation of and navigation through an image is conducted in accordance with the invention, a software object, shown in FIG. 4 as an interpolation operator or state S.sub.int 51 may be employed. This interpolation state is a collection of data values comprising a state vector that can be passed to the interpolation functions. Minimally, S.sub.int includes the following components: 1) the current user icon location/orientation; 2) the current location/orientation of a `proxy` user icon (associated with the potential target or destination of the user icon); 3) an INTERPOLATING flag; 4) a PROXY-PLACED flag; 5) the current time--T.sub.curr ; 6) the start time of the interpolation--T.sub.1 ; 7) the duration of the interpolation--T.sub.int ; 8) the elapsed time since the start of the interpolation--T.sub.x ; 9) other values used as arguments to one or more interpolation functions.

Detailed Description Paragraph Right (23):
FOLLOW--instantaneously orient the camera directly above the user icon location with a downward orientation, so that North is up in the viewport. This is a nadir, North-up, map view. The camera location may be at a fixed altitude, or its altitude may vary based on external factors, such as the height of the user icon, or the height of the terrain surface. In accordance with a preferred embodiment, altitude is one of a fixed number of discrete constant height values, which can be interactively selected by the user.

Detailed Description Paragraph Right (25):
ASCEND--at a finite rate, interpolate from the user icon location/orientation to the nadir, North-up, map view location/orientation.

Detailed Description Paragraph Right (26):
DESCEND--at a finite rate, interpolate from the nadir, North-up, map view location/orientation to the user icon location/orientation.

Detailed Description Paragraph Right (27):
A set of non-limiting examples of respective software modules for implementing the functionality and operation of the image manipulation and navigation methodology of the present invention will now be described with reference to the flow charts of FIGS. 8-17. It should be observed that the invention is not limited to the particular set of operations described and shown, but other image processing software routines which implement the functionality described may be employed.

Detailed Description Paragraph Right (28):
Referring initially to FIG. 8, which shows the overall operation of the image viewer, at step 801, the input devices are initialized and the graphical user interface is set up on the display. In addition, the 3D OpenInventor scene description is loaded from one or more files stored on the workstation's hard disk. Further, the initial user icon location/orientation is set, typically at the center of the scene, in the interpolation state S.sub.int. Also, the current simulation time is initialized at T.sub.0 in S.sub.int, and the INTERPOLATION flag is set as FALSE in S.sub.int.

Detailed Description Paragraph Right (30):
This is the default in-scene navigation behavior which modifies the user icon location/orientation in a straightforward manner based on input from the joystick. (As described above, pushing forward on the joystick moves the user icon location forward

in the scene. Pushing backward moves the user icon backward. Left and right movements behave similarly. Twisting the joystick handle changes the heading of the user icon's view. The amount of joystick displacement is directly proportional to the rate of change of the user icon's location or orientation.)

Detailed Description Paragraph Right (31):
The FOLLOW function for the inset view causes the overhead map view location and orientation to be calculated based on the location of the user icon in the scene. This function chooses a nadir viewpoint directly above the user icon. The altitude is fixed relative to the ground surface in the scene.

Detailed Description Paragraph Right (33):
From either of steps 803 and 804, the routine transitions to the update views step 805 (to be described below with reference to the flow chart of FIG. 9), wherein new camera views (viewer line-of-sight look angles) are computed. The camera views are then rendered to the display, and user interface device inputs are obtained for use in the calculation of the user's new location and orientation.

Detailed Description Paragraph Right (35):
Referring now to FIG. 9, which shows the details of the update views subroutine of step 805 of FIG. 8, at step 901, an interpolation elapsed time value T.sub.x is computed. As defined above, T.sub.x is the elapsed time since the start of the interpolation, or T.sub.curr -T.sub.1. If an interpolation sequence is not in progress, T.sub.curr =T.sub.1 and T.sub.x is 0. Next, at step 902, a new location and orientation is computed for each view camera by the interpolation function currently assigned to the view. The position of a respective camera (cam.sub.i =F.sub.i (S.sub.int)) is computed using the interpolation function assigned to the camera.

Detailed Description Paragraph Right (37):
Once the cameras have been placed and oriented, the update views routine transitions to step 903, wherein each view is rendered from its camera's point of view. Next, in step 904, the current time T.sub.curr is incremented by a delta amount T.sub.delta. The delta amount may be derived by sampling a real-time or system clock, or may be artificially generated in the case of a non-real-time simulation. Typically it is the refresh rate of the display, e.g., 1/30.sup.th of a second (for a fixed frame rate system), or the time required to render the previous frame (for a variable frame rate system).

Detailed Description Paragraph Right (45):
If the answer to query step 1009 is NO, the state of the middle mouse and placement of the proxy user icon are checked in query step 1010. If the middle mouse button is down and the proxy user icon has been placed in the image (the answer to query step 1010 is YES), the routine transitions to step 1020, (the details of which are shown in FIG. 17, to be described), wherein the proxy user icon is moved to a new location based on the mouse input, and the proxy user icon look-at point is relocated to retain the same orientation as the user icon.

Detailed Description Paragraph Right (46):
If the answer to query step 1010 is NO, the joystick is checked for input in query step 1011. If there is any joystick input (the answer to query step 1011 is YES), the joystick input is used in step 1021 to compute a new location/orientation for the user icon. In this step, a mathematical or procedural computation is executed using the input values and the interpolation state S.sub.int values to derive the new user icon parameters. This is sometimes referred to as a navigation model or a motion model.

Detailed Description Paragraph Right (48):
When the views are swapped, the locations of the main viewport camera and the inset viewport camera are moved smoothly to new locations. As a non-limiting example, two cameras may start at opposite ends of and move therefrom along the same path. However, an alternative camera motion scheme may be employed, such as having one motion when a camera is ascending, and a second motion when a camera is descending.

Detailed Description Paragraph Right (49):
FIG. 11A graphically illustrates a non-limiting example of an interpolation function that may be used to modify the overview camera's altitude, or Z coordinate, as it

moves into the scene. In FIG. 11A, a time variation 1151 shows the change in the `height` of the viewing camera (along an elevation or Z axis) above the viewed scene for a descend or `fly-down` transition. The camera starts moving at time t.sub.1, and its altitude decreases rapidly. As the camera gets lower, its rate of change of descent decreases. The camera eventually reaches its destination at time t.sub.int. Similarly, the camera's x,y and orientation parameters (heading, pitch and roll) may be interpolated by respective functions that together produce the desired motion. In a complementary fashion, time variation 1152 shows an ascend or `fly-up` operation. Also shown in FIG. 11A are time variations 1153 and 1154 (beginning at time t.sub.1 ') of the height of the viewing camera, in response to a reversal of respective descend and ascend image swapping transitions 1151 and 1152.

Detailed Description Paragraph Right (55):
FIG. 12 shows the details of the start view swap interpolation step 1015 of FIG. 10. As described briefly above, this subroutine is executed when two conditions are fulfilled: 1--an interpolation is not already in progress; and 2--the state of the view swap button changes. In step 1201, to indicate that an interpolation sequence is in progress, the INTERPOLATING flag is set to TRUE in S.sub.int. Next, in query step 1202, a determination is made whether the main view is currently showing the in-scene viewpoint. If so (the answer to query step 1202 is YES), the subroutine transitions to step 1203, wherein the main view interpolation function is set to ASCEND. On the other hand, if the main view is currently showing the overhead map view (the answer to step 1202 is NO), the main view interpolation function is set to DESCEND in step 1204.

Detailed Description Paragraph Right (56):
From either of steps 1203 and 1204, the subroutine transitions to query step 1205, to determine whether the inset view is currently showing the in-scene viewpoint. If so (the answer to query step 1205 is YES), the subroutine transitions to step 1206, wherein the inset view interpolation function is set to ASCEND. On the other hand, if the inset view is currently showing the overhead map view (the answer to step 1205 is NO), the main view interpolation function is set to DESCEND in step 1208. From either of steps 1206 and 1207, the subroutine of FIG. 12 is returned to the update views routine of FIG. 9.

Detailed Description Paragraph Right (57):
FIG. 13 shows the details of the subroutine for the place proxy user icon and look-at point start step 1016 of FIG. 10, used for initial placement of the proxy user icon for a place-and-orient operation. Both a point on the body of the proxy icon (either the head or the foot) and the proxy user icon look-at point are placed at the same location. Customarily, the user will want to relocate the look-at point to a new location.

Detailed Description Paragraph Right (58):
At query step 1301, it is initially determined whether the ray defined by the current camera location and the current mouse pointer position within the viewport intersects the 3D scene geometry. If the answer to query step 1301 is YES, that intersection point will be used for placement, and the routine transitions to mensuration mode query step 1302. If the answer to query step 1301 is NO, the subroutine returns to the update views subroutine of FIG. 9.

Detailed Description Paragraph Right (60):
FIG. 14 shows the details of the subroutine for the place proxy look-at point step 1017 of FIG. 10, for placing the proxy user icon look-at point in the scene. In query step 1401, it is determined whether the ray defined by the current camera location and the current mouse pointer position within the viewport intersects the 3D scene geometry. If the answer to query step 1401 is YES, that intersection point is used for placement, by setting the proxy user icon look-at point to the intersection point in step 1402. If not, the subroutine returns to the update views routine of FIG. 9.

Detailed Description Paragraph Right (62):
FIG. 15 shows the details of the subroutine for the start move-to interpolation step 1018 of FIG. 10, for starting the user icon move interpolation. This subroutine is entered only when the user has used the mouse to interactively choose a new location and orientation for the user icon. In step 1501, the INTERPOLATING flag is set to TRUE in S.sub.int, to indicate that an interpolation sequence is in progress. This causes

most user inputs to be temporarily ignored.

Detailed Description Paragraph Right (65):
FIG. 16 shows the details of the subroutine for the place proxy user icon preserving look-at offset step 1019 of FIG. 10, which is employed for a place-but-don't-reorient operation. The look-at point maintains a fixed offset from the proxy user icon, so that the orientation does not change even when the location changes. In query step 1601, it is initially determined whether the ray defined by the current camera location and the current mouse pointer position within the viewport intersects the 3D scene geometry. If the answer to query step 1601 is NO, the subroutine returns to the update views subroutine of FIG. 9.

Detailed Description Paragraph Right (67):
FIG. 17 shows the details of the subroutine for the move proxy user icon preserving look-at offset step 1020 of FIG. 10, which is employed for moving the proxy user icon, while maintaining its orientation. In query step 1701, it is initially determined whether the ray defined by the current camera location and the current mouse pointer position within the viewport intersects the 3D scene geometry. If the answer to query step 1701 is NO, the subroutine returns to the update views subroutine of FIG. 9. If the answer to query step 1701 is YES, however, that intersection point will be used for placement, and the routine transitions to step 1702, wherein an offset vector (a 3D vector) is computed, by subtracting the user icon foot location from the user icon look-at point location. Next, in step 1703, the proxy user icon foot is placed at the intersection point. In step 1704, the offset vector is used to place the look-at point relative to the foot. This is carried out by adding the offset vector to the foot location to get the location of the proxy user icon look-at point. The subroutine then returns to the update views routine of FIG. 9.

Detailed Description Paragraph Right (68):
The operation of the view-swapping functionality of the present invention will now be described with reference to the state diagram of FIG. 18, and the toggle position, in-scene/overview diagrams of FIGS. 19 and 20. As pointed out previously, the roles and viewpoints of the main viewport and the inset viewport may be readily swapped by the operation of a toggle switch on an input device. Since the two views are mutually synchronized, the user's viewing `cameras` move in a coordinated fashion to swap locations, and the two viewports swap display roles.

Detailed Description Paragraph Right (69):
Consider for example, the dual view display shown in FIG. 19, where the larger main viewport 21 is displaying the in-scene view of a building 1900, while the inset viewport 22 is displaying the overview (map/bird's eye) view taken from the front of the building. Also shown in the inset viewport 22 of FIG. 19 are a user icon 1910 and an associated field of view 1920, to be described in detail below with reference to FIG. 28. This view mode corresponds to state 1801 of FIG. 18, and is typically employed for viewing ground level objects within an urban virtual world. In this state, the user is readily able to navigate through (change the user's location, orientation in) the in-scene view, by using the joystick or mouse to turn, move in any horizontal direction, and rise or descend, as described previously. The complement of this view mode corresponds to state 1805 of FIG. 18, in which the user may navigate through the overview view (using a different navigation model from that employed for navigating through the in-scene view).

Detailed Description Paragraph Right (70):
For purposes of providing a non-limiting example, in the present description, the meaning of the toggle pushbutton is defined as follows: when the button is up (at 2001 in FIG. 20) the main viewport 21 transitions to the overview, and the inset viewport 22 transitions to the in-scene view; when the button is down (at 1901 in FIG. 19), the main viewport 21 transitions to the in-scene view, and the inset viewport 22 transitions to the overview view. Using this convention, when a user device toggle switch is raised, corresponding to the transition from state 1801 to state 1802 in the state diagram of FIG. 18, the transient image navigation subroutines of FIGS. 8-17, detailed above, are executed to reverse or swap the viewpoints of the overview and in-scene views (toward A and B in state 1802, or toward B and A, in state 1806).

Detailed Description Paragraph Right (73):

This allows the user to ascend fully to the overview map viewpoint, or to rise up just far enough to realize where he/she is, and then immediately return to street level of the virtual 3D image. This feature also provides a convenient mix of close-up, on-the-street navigation with longer-range navigation. The user on-the-street can `pop up` to the overview viewpoint, roam quickly to a distant part of the scene, and then descend back to street level in the new location. It additionally avoids the problem of having to provide appropriate scale factors to a single navigation model for both the close-up and long-range motions, and avoids the distraction of forcing the user to decide when to use one or the other. Since toggling between viewports exchanges one motion model for another, without bringing it to the user's attention, the user maintains his/her focus on the virtual world and not on the software tool.

Detailed Description Paragraph Right (75):
Next, as pictorially shown in FIG. 23, while holding down the left mouse button, the user moves the mouse to the desired look-at or target point (shown at point 2302 in FIG. 23), that will be viewed when the view of the scene is transitioned from the user's current location or vantage point (as viewed in FIG. 21) to the new vantage point 2302. The new look-at point 2302 will be used to orient the user when standing at the new vantage point 2201. As shown by the (reduced complexity--two step) view sequence of FIGS. 24 and 25, the image being displayed to the user then transitions (using interpolation based smoothing) from the scene image as currently being viewed in FIG. 21 to that portion of the scene containing the new look-at point (2302 in FIG. 23) as it will be viewed from the user's new location or vantage point 2201.

Detailed Description Paragraph Right (77):
FIGS. 26 and 27 show the interactive placement of the user icon, allowing the user to change location but not relative viewpoint orientation through the operation of the middle mouse button. FIG. 26 shows placement of the user icon at a vantage location 2601 by pressing the middle mouse button. The relative target or look-at location is shown at 2602. There is no control over the icon's relative viewpoint orientation. FIG. 27 shows another placement of the vantage point to location 2701. The new look-at location 2702 relative to the new vantage point 2701 in the image of FIG. 27 remains relatively the same as the look-at location 2602 is to the vantage point 2601 in FIG. 26.

Detailed Description Paragraph Right (83):
Although the reduced complexity user icon shown in FIGS. 28 and 29 has an artificial appearance, the above-described features may be incorporated into a much more `human`-looking iconic representation. Such a shape may provide the additional benefit of a familiar scale of reference, that the human user could employ as an additional visual cue, to aid in estimating the sizes of objects within the scene. The user icon may also be employed for navigation under mouse control and for mensuration.

Detailed Description Paragraph Right (85):
In this mode, as shown in FIG. 30, moving the user location/orientation interactively allows the user to select respective proxy vantage and look-at points 201 and 202. During the selection process, a mensuration icon 200 is displayed between the proxy vantage and look-at points. In addition, as shown by a parameter box 203, the display is operative to show parametric values associated with distance between the proxy vantage and look-at points, change in horizontal distance, and change in elevation next to the mouse pointer. Upon completion of the proxy viewpoint specification, the user's viewpoint does not change, as when moving to a new location. This allows the user to measure additional features within the displayed 3D image.

Detailed Description Paragraph Right (96):
As will be appreciated from the foregoing description, by controllably rendering and displaying multiple (swappable) aspect and size views of a three-dimensional geometric model, the present invention not only surpasses the limited capabilities of conventional three-dimensional model display system, but facilitates navigation and mensuration within the virtual world of the in-scene view of the displayed image.

CLAIMS:

1. A method of displaying and manipulating an image of a three-dimensional (3D) geometric model of an object, such as an urban scene, comprising the steps of:

(a) simultaneously displaying, in a first display window of a digital image display system, a first image of said object that presents said object from a first 3D model perspective and, in a second display window of said digital image display system, a second image of said object that presents said object from a second 3D model perspective, different from said first 3D model perspective; and

(b) simultaneously performing an effectively continuous transition of the image contents of said first display window from said first 3D model perspective of said object toward said second 3D model perspective of said object, and an effectively continuous transition of image contents of said second display window from said second 3D model perspective of said object toward said first 3D model perspective of said object.

2. A method according to claim 1, wherein said first 3D model perspective presents an overview image of said object from a first distance map perspective, and said second 3D model perspective presents an in-scene image of said object from a second distance perspective, closer to said object than said first distance map perspective.

3. A method according to claim 2, further including the step of:

(c) manipulating said in-scene image of said object in a manner that displays movement through said in-scene image from a perspective different from said overview image of said object.

4. A method according to claim 1, further including the step (c) of, during step (b), controllably reversing said effectively continuous transition of image contents of said first display window, and said effectively continuous transition of image contents of said inset viewport display window.

6. A method according to claim 1, wherein step (a) further comprises controllably introducing, in a successive animated manner, images of a selected portion of said three-dimensional (3D) geometric model of said object into said first and second display windows of said digital image display device, in accordance with object model introduction representative signal inputs from said user interface.

7. A method of displaying and manipulating an image of a three-dimensional (3D) geometric model of an object, such as an urban scene, comprising the steps of:

(a) displaying, in an overview viewport display window of a digital image display system, a first image of said object that presents said object from a first 3D model perspective, said overview viewport display window having a first display area;

(b) displaying, in an inset viewport display window of said digital image display system, a second image of said object that presents said object from a second 3D model perspective, different from said first 3D model perspective, said inset viewport display window having a second display area different than said first display area; and

(c) navigating through said second image of said object, so as to manipulate said second image of said object displayed in said inset viewport display window.

8. A method according to claim 7, wherein step (c) includes displaying a virtual user icon within said second image, and operating a user interface of said digital image display system in a manner that is effective to manipulate the 3D location and/or orientation of said virtual user icon within said second image.

10. A method according to claim 9, wherein step (c) comprises operating said user interface to locate said second user viewing location in said second image, locating a look-at location in said second image so as to define said second in-scene viewing direction from said second user viewing location in said second image of said second 3D model perspective of said object, and thereafter effecting movement through said second image, from said first user viewing location to said second user viewing location, while displaying said look-at location of said second image as viewed while traveling along a navigation path from said first user viewing location to said second

user viewing location.

14. A method according to claim 7, wherein step (c) includes using an interpolation mechanism to manipulate said second image of said object so as to display a gradual continuous movement of said second image as viewed from different user locations of said second 3D model perspective of said object.

15. A method according to claim 7, wherein step (a) comprises maintaining said first image of said object in a fixed display orientation while navigating through said second image of said object in step (c).

17. A method according to claim 7, further including step (d) of performing an effectively continuous transition of image contents of said overview viewport display window from an overview image of said object having a first distance perspective, toward an in-scene image of said object having a second distance perspective, that is closer to said object than said first distance perspective, while simultaneously performing an effectively continuous transition of image contents of said inset viewport display window from said in-scene image of said object toward said overview image of said object.

18. A method according to claim 17, further including step (e) of, during step (d), controllably reversing said effectively continuous transition of image contents of said overview viewport display window toward said in-scene image, and said effectively continuous transition of image contents of said inset viewport display window from said in-scene image of said object toward said overview image of said object.

20. A method according to claim 7, wherein steps (a) and (b) further comprise controllably introducing, in a successive animated manner, different views of a selected portion of said first and second images of said three-dimensional (3D) geometric model of said object into said overview and inset viewports of said digital image display device, in accordance with object model introduction representative signal inputs from said user interface.

21. A virtual user icon for a display and manipulation of a image of a three-dimensional (3D) geometric model of an object, such as an urban scene, in a display window of a digital image display system, comprising a viewpoint element that is configured to simulate a user's head at a user viewing location in said image, a viewing direction indicator including a line-of-sight therefrom, and a look-at point element positionable at a viewed location in said image.

23. An image processing system comprising:

a digital image display device;

a digital image processor which is operative to operate upon a three-dimensional (3D) geometric model of an object, such as an urban scene, and to controllably display multiple images of said object upon said digital image display device; and

a user interface coupled to said digital image processor and being operative under user control to supply image manipulation signals to said digital image processor for causing the manipulation of images displayed upon said digital image display device; and wherein

said digital image processor is operative to simultaneously display in a first display window of a digital image display device a first image of said object that presents said object from a first 3D model perspective, and to display in a second display window of said digital image display system a second image of said object that presents said object from a second 3D model perspective, different from said first 3D model perspective and, in response to a first prescribed operation of said user interface, to simultaneously cause an effectively continuous transition of the image contents of said first display window from said first 3D model perspective of said object toward said second 3D model perspective of said object, and an effectively continuous transition of image contents of said second display window from said second 3D model perspective of said object toward said first 3D model perspective of said object.

24. An image processing system according to claim 23, wherein said digital image processor is operative, in response to a second prescribed operation of said user interface, to controllably reverse said effectively continuous transition of image contents of said first display window, and said effectively continuous transition of image contents of said inset viewport display window.

26. An image processing system according to claim 25, wherein said digital image processor is operative to manipulate said in-scene image of said object in a manner that displays movement through said in-scene image from a perspective different from said overview image of said object.

27. An image processing system according to claim 26, wherein said digital image processor is operative to cause said display device to display a virtual user icon within said in-scene image, and to manipulate the 3D location and/or orientation of said virtual user icon within said in-scene image in accordance with operation of said user interface.

28. An image processing system according to claim 23, wherein said display device maintains said overview image of said object in a fixed display orientation during navigation through said in-scene image of said object.

29. An image processing system according to claim 23, wherein said digital image processor is controllably operative to introduce, in a successive animated manner, views of a selected portion of said three-dimensional (3D) geometric model of said object into said first and second display windows of said digital image display device, in accordance with object model introduction representative signal inputs from said user interface.

30. An image processing system comprising:

a digital image display device;

a digital image processor which is operative to operate upon a three-dimensional (3D) geometric model of an object, such as an urban scene, and to controllably display multiple images of said object upon said digital image display device; and

a user interface coupled to said digital image processor and being operative under user control to supply image manipulation signals to said digital image processor for causing the manipulation of images displayed upon said digital image display device; and wherein

said digital image display device contains an overview viewport display window displaying a first image of said object that presents said object from a first 3D model perspective, said overview viewport display window having a first display area, and an inset viewport display window displaying a second image of said object that presents said object from a second 3D model perspective, different from said first 3D model perspective, said inset viewport display window having a second display area different than said first display area; and

said digital image processor is controllably operative to navigate through said second image of said object in accordance with navigation signal inputs from said user interface, so as to manipulate said second image of said object displayed in said inset viewport display window.

31. An image processing system according to claim 30, wherein said digital image processor is operative to cause said digital image display device to display a virtual user icon within said second image, and to manipulate the 3D location and/or orientation of said virtual user icon within said second image in response to operation of said user interface, and thereby display movement through said second image, from a first in-scene viewing location to a second in-scene viewing location of said second 3D model perspective of said object.

32. An image processing system according to claim 30, wherein said digital image processor is operative to execute an interpolation mechanism to manipulate said second

image of said object so as to display a gradual continuous movement of said second image as viewed from different user locations of said second 3D model perspective of said object.

36. An image processing system according to claim 30, wherein said digital image processor is operative to cause said display device to display a mensuration icon that interconnects respective look-from and look-at points in said second image.

37. An image processing system according to claim 30, wherein said digital image processor is operative to cause an effectively continuous transition of image contents of said overview viewport display window from an overview image of said object having a first distance perspective, toward an in-scene image of said object having a second distance perspective, that is closer to said object than said first distance perspective, while simultaneously causing an effectively continuous transition of image contents of said inset viewport display window from said in-scene image of said object toward said overview image of said object.

38. An image processing system according to claim 37, wherein said digital image processor is operative, in response to a second prescribed operation of said user interface, to controllably reverse said effectively continuous transition of image contents of said overview viewport display window toward said in-scene image, and said effectively continuous transition of image contents of said inset viewport display window from said in-scene image of said object toward said overview image of said object.

39. An image processing system according to claim 30, wherein said digital image processor is controllably operative to introduce, in a successive animated manner, views of a selected portion of said three-dimensional (3D) geometric model of said object into said overview and inset viewports of said digital image display device, in accordance with object model introduction representative signal inputs from said user interface.

40. An image processing system comprising:

a digital image display device;

a digital image processor which is operative to process a three-dimensional (3D) geometric model of an object, such as an urban scene, and to controllably display an image of said object within a viewport of said digital image display device; and

a user interface coupled to said digital image processor and being operative under user control to supply image manipulation signals to said digital image processor for causing the manipulation of an image displayed within said viewport of said digital image display device; and wherein

said digital image processor is controllably operative to introduce, in a successive animated manner, at least one selected portion of said three-dimensional (3D) geometric model of said object, into said viewport of said digital image display device, in accordance with object model introduction representative signal inputs from said user interface.

41. An image processing system according to claim 40, wherein said digital image processor is operative to controllably grow, at a prescribed location of said viewport of said digital image display device, and in said successive animated manner, said at least one selected portion of said three-dimensional (3D) geometric model of said object from a first size to a second size, in response to said object model introduction representative signal inputs from said user interface.

42. An image processing system according to claim 40, wherein said digital image processor is operative to controllably translate into a prescribed location of said viewport of said digital image display device, and in a successive animated manner, said at least one selected portion of said three-dimensional (3D) geometric model of said object, in response to said object model introduction representative signal inputs from said user interface.

43. An image processing system according to claim 40, wherein said digital image display device contains an overview viewport display window displaying a first image of said object that presents said object from a first 3D model perspective, said overview viewport display window having a first display area, and an inset viewport display window displaying a second image of said object that presents said object from a second 3D model perspective, different from said first 3D model perspective, said inset viewport display window having a second display area different than said first display area, and wherein said digital image processor is controllably operative to introduce, in said successive animated manner, different views of said at least one selected portion of said three-dimensional (3D) geometric model of said object into said overview and inset viewports of said digital image display device, in accordance with said object model introduction representative signal inputs from said user interface.

44. An image processing system according to claim 40, wherein said digital image processor is operative to execute an interpolation mechanism to successively introduce said at least one selected portion of said three-dimensional (3D) geometric model of said object into said viewport of said digital image display device.

45. An image processing system according to claim 40, wherein said digital image processor is operative to controllably remove, in a successive animated manner, at least one prescribed portion of said three-dimensional (3D) geometric model of said object displayed by digital image display device.

46. An image processing system according to claim 40, wherein said digital image processor is operative to controllably remove, in a successive animated manner, said at least one selected portion of said three-dimensional (3D) geometric model of said object that has been introduced into and displayed by digital image display device.

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DOCUMENT-IDENTIFIER: US 4796189 A
TITLE: Navigation system for automotive vehicle with automatic navigation start and navigation end point search and automatic route selection

Abstract Paragraph Left (1):
A navigation system has a map memory storing map data. The road map stored in the map memory is divided into a plurality of pages further subdivided into continuous blocks. The map memory also stores identification data for the blocks and index data for various points within the map blocks. The index data includes position data for a plurality of known points. The navigation system also includes an input unit for entry of the identification data for a map memory block and/or the index data for known points, and a display unit for displaying a map block on a display monitor. A processor of the navigation system accepts entry of the index data for a travel starting point and a destination through the input unit. Based on the entered data, the processor searches for the map blocks containing the designated known points. The processor progressively expands the search area along a vector between the travel starting point and the destination. The process finds the known point closest to the travel starting point and the other known point closest to the destination along the vector and stores these as the navigation start point and the navigation end point.

Brief Summary Paragraph Right (1):
The present invention relates generally to a navigation system including a road map display showing a road map and guiding the vehicle through a preset driving route. More specifically, the invention relates to a navigation system which automatically locates the navigation start and end points in response to entry of the vehicle position and destination position.

Brief Summary Paragraph Right (2):
In recent years, various vehicular navigation systems for guiding vehicles through present travelling routes have been developed. Some navigation systems include a map display on a display monitor, such as a CRT display. In such systems, map data are stored in a high-capacity map memory, such as a CD ROM or the like. The map memory is generally divided into a plurality of pages representing separate, contiguous map areas. Each map area is further divided into a plurality of map blocks which generally correspond to one screen-ful on the display monitor. Each map area and/or map block includes an identification code or number.

Brief Summary Paragraph Right (3):
Due to the relatively voluminous data stored in the map memory, it is sometimes difficult to access the appropriate map block including the vehicle starting point and the destination. Some systems allow automatic access to the appropriate map block by means of manual entry of the rough position of the starting point and the destination. Even in such cases, when a large number of map blocks are later isotropically searched for suitable route point, search time tends to be unacceptably long. On the other hand, when the scanning area is limited, it sometimes happens that the appropriate map block can not be found due to errors in the map data.

Brief Summary Paragraph Right (4):
Therefore, it is an object of the present invention to provide a navigation system for an automotive vehicle, which can effectively and quickly locate the map block containing a desired point.

Brief Summary Paragraph Right (5):
Another and more specific object of the present invention is to provide a navigation system which can quickly and automatically find map points corresponding to designated navigation start and end points.

Brief Summary Paragraph Right (6):
In order to accomplish the aforementioned and other objects, a navigation system according to the present invention, has a map memory storing map data. The road map stored in the map memory is divided into a plurality of pages further subdivided into contiguous blocks. The map memory also stores idetification data for the blocks and index data for various points within the map blocks. The index data includes position data for a plurality of known points. The navigation system also includes an input unit for entry of the identification data for a map memory block and/or the index data for known points, and a display unit for displaying a map block on a display monitor. A processor of the navigation system accepts entry of the index data for a travel starting point and a destination through the input unit. Based on the entered data, the processor searches for the map blocks containing the designated known points. The processor progressively expands the search area along a vector between the travel starting point and the destination. The processor finds the known point closest to the travel starting point and the other known point closest to the destination along the vector and stores these as the navigation start point and the navigation end point.

Brief Summary Paragraph Right (7):
According to one aspect of the invention, a navigation system for an automotive vehicle comprises first means for monitoring vehicle motion and deriving first data indicative of vehicle traveling data, second means for storing a map which is separated into a plurality of blocks and includes a plurality of known points, third means for entry of position data of at least a start point and a destination, fourth means allowing selection of a route for the vehicle and storing the selected routine, the fourth means storing second data indicative of a navigation start point, a navigation end point, designated known points along the route and between the navigation start point and the navigation end point, and a predetermined condition for detecting when the vehicle reaches each of the designated known points, the fourth means determining the navgiation start point and the navigation end point by searching the known points within a search area which is expandable in a limited direction determined based on a direction of a straight line extending through the start point and the destination, fifth means for displaying the map stored in the third means, and a symbol representing the vehicle position, and sixth means for setting a travel zone between successive designated known points and displaying instantaneous position of the vehicle, the sixth means monitoring vehicle position within the travel zone, detecting when the predetermined condition is satisfied and in such cases, and renewing the travel zone

Brief Summary Paragraph Right (15):
According to another aspect of the invention, a navigation system for an automotive vehicle comprises a map memory storing a road map which is divided into a plurality of pages further subdivided into contiguous blocks, the map memory also storing idetification data for the blocks and index data for various points within the map blocks, which index data includes position data for a plurality of known points, an input unit for entry of the identification data for a map memory block and/or the index data for known points, a display unit for displaying a map block on a display screen, a processor accepting entry of the index data for a travel starting point and a destination through the input unit, searching for the map blocks containing the designated known points based on the entered data, the processor progressively expanding the search area along a vector between the travel starting point and the destination, the processor finding the known point closest to the travel starting point and the other known point closest to the destination along the vector and stores these as the navigation start point and the navigation end point, and the processor further determining a route between the navigation start point and the navigation end point.

Brief Summary Paragraph Right (16):
According to a further aspect of the invention, a process for navigation of a vehicle along a preset route comprises the steps of:

Brief Summary Paragraph Right (17):
providing a road map which is divided into a plurality of map blocks and including data for a plurality of known points on a map;

Brief Summary Paragraph Right (18):
providing input data defining a start point and a destination;

Brief Summary Paragraph Right (19):
displaying the road map on a visual display screen;

Brief Summary Paragraph Right (20):
searching in a given search area for finding out the known points which are closest to the start point and destination for designation as a navigation start point and a navigation end point, the given search area originally corresponding to an area of each of the map blocks in which the start point and the destination exists and being progressively expanded toward a limited direction which is determined based on a direction between the start point and the destination;

Brief Summary Paragraph Right (21):
presetting a route between the navigation start point and the navigation end point across the map and designating known points along the preset route;

Brief Summary Paragraph Right (26):
shifting vehicle position indicative symbol to the designated known point on the display; and

Brief Summary Paragraph Right (34):
(b) sectoring the field about the start point;

Brief Summary Paragraph Right (35):
(c) identifying a target sector in which lies a straight-line vector from the start point to the end point;

Brief Summary Paragraph Right (36):
(d) defining a search area, initially enclosing only the block in which the start point lies;

Brief Summary Paragraph Right (40):
(h) defining the point found in step (e) as the start point;

Brief Summary Paragraph Right (42):
Preferably, the foregoing step (h) further comprises the steps of finding which of the points found in step (e) lies closest to the start point, in cases where more than one point is found in step (e).

Drawing Description Paragraph Right (2):
FIG. 1 is a block diagram of the preferred embodiment of the navigation system according to the present invention;

Drawing Description Paragraph Right (3):
FIGS. 2 and 3(A) to 3(C) show the roadmap data format used in a map data storage unit shown in FIG. 1;

Drawing Description Paragraph Right (4):
FIG. 4 is a flowchart for initialization of navigation in the preferred embodiment of the navigation system of FIG. 1;

Drawing Description Paragraph Right (5):
FIG. 5 shows an example of a displayed map index;

Drawing Description Paragraph Right (6):
FIG. 6 is an explanatory illustration showing a manner of derivation of search area by dividing the map coordinate system into a plurality of sectors;

Drawing Description Paragraph Right (7):

FIGS. 7(A) and 7(B) are explanatory illustration showing structure of the road map and manner of expanding of the search area according to the present invention;

Drawing Description Paragraph Right (10):
FIGS. 10 and 11 are exemplary displays for guiding the vehicle to the navigation start point;

Drawing Description Paragraph Right (11):
FIG. 12 is a flowchart of the process of navigation to the navigation start point;

Drawing Description Paragraph Right (15):
FIGS. 16 and 17 are exemplary displays during vehicle travel within an update zone;

Drawing Description Paragraph Right (21):
FIG. 23 is an illustration of a display generated at a step 1108 of FIG. 22;

Drawing Description Paragraph Right (23):
FIG. 25 is a diagram showing typical updates of the vehicle symbol on the display; and

Drawing Description Paragraph Right (24):
FIG. 26 is a flowchart of a program for updating the display.

Detailed Description Paragraph Right (1):
Referring now to the drawings, particularly to FIG. 1, the preferred embodiment of a navigation system according to the present invention will be disclosed in order to facilitate better understanding of the detailed description of the present invention.

Detailed Description Paragraph Right (2):
It should be noted that the term "updating point" or "update point" used throughout the disclosure means preset target points of known position along a route to a given destination and the coordinates of which are stored in memory. Intersections, major curves and so forth may be selected for use as target points. Also, the term "travel zone" represents a zone or section in the preset route between update points. The first of the two update points defining the travel zone, i.e. the one from which the vehicle starts, will be referred to as "first update point". The other update point will be hereinafter referred to as "second update point". The update point or target point subsequent to the second update point will be hereafter referred to as "third update point" or "third target point". Furthermore, the term "update zone" represents an area or zone around the second update point defined for use in monitoring when vehicle passes the second update point.

Detailed Description Paragraph Right (3):
FIG. 1 shows the preferred embodiment of the navigation system for implementing a method for detecting update points along a preset vehicle route.

Detailed Description Paragraph Right (4):
The navigation system includes a vehicle direction of travel sensor 21 which may comprise a magnetic compass, for example. The preferred construction of the magnetic compass is as disclosed in SAE paper SP-80/458/SO2.05, published by the Society of Automotive Engineering, No. 800123 by H. Ito et al. or 3-axis Rate Gyro Package Parts No. PG24-N1, of Kabushiki Kaisha Hakushin Denki Seisakusho, February, 1979. Also, a suitable magnetic compass is disclosed in British Patent First Publication No. 2,102,259, published on Jan. 26, 1983, which corresponds to German Patent First Publication No. 32 17 880, published on Nov. 25, 1982, British Patent First Publication No. 2,100,001, published on Dec. 15, 1982, which corresponds to German Pat. First Publication No. 32 13 630, published on Nov. 18, 1982, and German Patent First Publication No. 33 05 054, published on Aug. 25, 1983. The contents of the above-identified publications are hereby incorporated for the sake of disclosure.

Detailed Description Paragraph Right (6):
The direction of travel sensor 21 is connected to a processing unit 31 via a sensor amplifier 23 which amplifies the direction of travel indicative sensor signal produced by the travel direction sensor, and a sensor interface 45 in the processing unit. The travel distance sensor 25 is also connected to the processing unit 31 via the sensor

interface 45. The processing unit 31 has an output port 49 connected to a display unit 27 which includes buffer memories 33 and 34, a display controller 35 and a display device 37 which may be a CRT monitor, for example. The processing unit 31 also has an input port 47 connected to an input unit 29 including a key-switch array 41 and a transparent touch panel 39 which comprises a plurality of pressure responsive segments or thermo-responsive segments which accepts inputs by way of touching different points on the display screen. The touch panel 39 overlies the map displayed on the display screen to allow convenient input of position data. The function of the touch panel 39 can be imagined as being equivalent to the conventional light pen.

Detailed Description Paragraph Right (7):
The processing unit 31 comprises a microprocessor made up of the aforementioned sensor interface 45, an input port 46, the output port 49, and in addition, built-in CPU, ROM and RAM units. A monolithic prcessing unit constructed as set forth above may serve as the microprocessor for ease of installation in the vehicular space. The processing unit 31 also includes a map memory 50 which stores map data for various locations. In order to store an adequately large volume of map data, the map memory 50 may be an external memory with a large-capacity storage medium, such as a read-only compact disk (CD). The processor unit 31 further includes a temporary data memory 51 for storing data concerning the preset route including position data, intersection configuration data and so forth for the preset update points.

Detailed Description Paragraph Right (8):
The contents of the map memory is disclosed with reference to FIGS. 2 and 3(A) to 3(C). FIGS. 2 and 3(A) to 3(C) illustrate an example of the structure of the roadmap data stored in the roadmap data storage unit 18 shown in FIG. 1. For example, each regional roadmap such as Japan national, Hokkaido, Tohoku, Kanto, Central, Kansai, Chugoku, Shikoku, Kyushu, and so on is further divided into a plurality of individual regions. The roadmap information for each region is stepwise divided from upper divisions such as national roads (interstate freeways in the United States) to lower divisions such as regional roads (Prefectural roads and City roads).

Detailed Description Paragraph Right (9):
The storage area within the storage unit 18 is divided into a plurality of blocks corresponding to regional areas 31 into which the map (FIG. 2) is subdivided. In addition, each block is subdivided into a plurality of intersection areas, each including information on configuration of the intersection, such as a T-type of cross-type, X-Y coordinate information for identifying the location of the intersection, the intersection name, and the intersection number, connecting road number, direction, and distance to all neighboring major intersections.

Detailed Description Paragraph Right (10):
Practical operation of the preferred embodiment of the navigation system of FIG. 1 will be described in detail with reference to FIGS. 2 to 26.

Detailed Description Paragraph Right (11):
The navigation system becomes active in response to closure of a power supply switch. After the power comes on, the system enters a stand-by state in which it awaits entry of data. Therefore, a step 100 checks for data entry, as shown in FIG. 4. In general, data entry is mediated by the key-switch array 1 of the input unit 29. The data to be entered includes the starting point and the destination. The preferred embodiment of the navigation system can accept the initial data for the starting position and the destination in either of two modes, referred to as "precise data entry" and "rough data entry". Both modes of data entry will be described hereinafter.

Detailed Description Paragraph Right (13):
Precise data entry may be performed by pointing the precise starting point and destination on the road map display. In this case, the map block or blocks in including the starting point and the destination are selected by entering identification codes thereof through the key-switch array 1 of the input unit 29. Upon entry of the identification code, the road map block in the map memory 50 is read out and displayed on the display screen. The starting point and the destination on the displayed map can be pointed out by means of the touch panel 39. The touch panel 39 produces a position signal representing x- and y-coordinates of the point touched on the displayed map. The position signal is decoded and stored as the coordinates of the

starting point and the destination.

Detailed Description Paragraph Right (15):
Rough data entry does not require the exact position of the starting point and the destination to be pointed out. When rough data entry is desired, an index of individual unit areas of the road map are displayed on the display screen, in the manner shown in FIG. 5. As shown in FIG. 5, the index includes the names and codes of map divisions and the names and codes of individual unit areas included in the corresponding division. With reference to the displayed index, the identification code of the individual unit areas of the starting point and the destination are input through the key switch array 1 of the input unit.

Detailed Description Paragraph Right (16):
The step 100 in the initialization program of FIG. 4 is repeated until all the above data entry has been performed. Thereafter, target points to be taken as navigation start and end points are determined, at a step 102. The navigation start and end points are determined by executing a sub-routine of FIG. 8, which will be described later.

Detailed Description Paragraph Right (17):
In general, the navigation starting point and the navigation end point are selected from among target points located nearest the starting point and the destination. In order to select the target points serving as the navigation start point and the navigation end point quickly and effectively, the map coordinate system is divided into a plurality of equi-angular sectors, e.g. into 8 sectors. The area of search for the update points to be used as the navigation start point and the navigation end point will be limited to the sector which includes a line between the starting point and the destination. In the shown embodiment, the map coordinate system is divided into 8 sections (V=1 to V=8), as shown in FIG. 6. Therefore, as shown in FIG. 7(A), assuming the vehicle starting point Z.sub.s (x.sub.s, y.sub.s) is in the map block identified by map block identification (X, Y) and that the destination Z.sub.D (x.sub.D, y.sub.D) is located in a direction lying within the sector (V=1) in FIG. 6, the search for the navigation start point starts within the map block (X, Y). If at least one target point is found in the map block (X, Y), all the remaining target points in the corresponding map block (X, Y) by setting the map block as the search area. On the other hand, if no target point are found in the map block (X, Y), the search area is expanded to some of the adjoining map blocks. As will be seen from FIG. 7(A), the map blocks (X, Y+1), (X+1, Y+1), (X+1, Y), (X+1, Y-1) and (X, Y-1) adjoin the map block (X, Y) in the general direction of the destination. These map blocks within the sector (V=1) are then selected so as to expand the search area. Therefore, in the next time, the search for the target point to be assigned for use as the navigation start point is conducted over these six map blocks. As above, if no target points are found in the expanded search area, the area is again expanded along the x-axis (in the case of V=1), and this is repeated until a target point is found. If more than one target point is located, the closest one to the starting point is selected as the navigation start point.

Detailed Description Paragraph Right (18):
Similarly, in the case where the direction to the destination Z.sub.D from the starting point Z.sub.S lies within the sector (V=2), the search area is expanded along both x- and y-axes, as shown in FIG. 7(B), so that the search area takes the form of a square quadrant.

Detailed Description Paragraph Right (19):
The coordinates of the navigation start and end points are stored for later use. After completing the process in the step 102, a sub-routine for determining the travel route is performed at a step 104. The sub-routine is shown in FIG. 9. In the sub-routine of FIG. 9, all of the target points to be used as updating points are determined one-by-one so as to find the shortest possible route.

Detailed Description Paragraph Right (20):
FIG. 8 shows a flowchart of a subroutine at the step 102 in the program of FIG. 4. At a step 102-1, checking is performed whether at least one target point to be an update point is exists in a map block in which the starting point or the destination exists. If at least one update point is found in the corresponding block as checked at the

step 102-1, then the block is assigned as a search area at a step 102-2. Thereafter, all of the update points in the search area are searched at a step 102-3. At the same step 102-3, the update points closest to the starting point and the destination are selected to assign as the navigation start point and the navigation end point.

Detailed Description Paragraph Right (21):
On the other hand, when no update point is found in the block wherein the starting point and the destination exist, the process goes to a step 102-4 to derive a route direction based on the position of the starting point and the destination. A map identification value A is set to 1 at a step 102-5. Thereafter, the route direction is checked against the sectors V=1 to V=8 of FIG. 6, at a step 102-6. Then, the process at the step 102-7, one of the series of operation is performed for controlling expansion of the search area and for finding out update point or update points within the search area. For instance. assuming the route direction is involved in the sector V=1 as checked at a step 102-6, then search area is expanded over the map blocks (X, Y+1), (X+1, Y+1), (X+1, Y), (X+1, Y-1) and (X, Y-1) adjoining the map block (X, Y) at a sub-step 102-8. Then, at a step 102-9, checking is performed whether at least one target point to be an update point exists in the search area. If at least one update point is found in the corresponding block as checked at the step 102-9, then the process goes to the step 102-2. Similarly to the foregoing, in the step 102-2, the blocks (X, Y+1), (X+1, Y+1), (X+1, Y), (X+1, Y-1) are assigned as a search area. Thereafter, all of the update points in the search area are searched at a step 102-3. At the same step 102-3, the update point closest to the starting point and the destination are selected to assign as the navigation start point and the navigation end point.

Detailed Description Paragraph Right (22):
If an update point cannot be found even after expansion of the search area, the map block identification value A is incremented by 1 at sub-step 102-10. Then, at the sub-step 102-8, the search area is again expanded.

Detailed Description Paragraph Right (23):
By such procedure, expansion of the search area for finding the update point or points can be performed in a substantially limited area around the route direction. This saves search time for effectively determining the navigation start point and the navigation end point.

Detailed Description Paragraph Right (24):
At the first cycle of sub-routine execution, the navigation start point determined at the step 102 is taken as the first update point at a step 106, shown in FIG. 9. Then, all of the adjoining target points around the first update point are found and checked at a step 108. Based on the known positions of these target points, the distance to each target point is calculated at a step 110. The resultant distance values are temporarily stored. After this, the target points adjoining each of the second target points uncovered in the step 108 are located at a step 112. The distances between the second and these third target points are calculated at a step 114. Thereafter, the distances between the first update and the third target points are calculated at a step 116. The smallest of the resultant distance values obtained at the step 116 is selected so that the target points along the shortest route are selected as the second and third update points, at a step 118. The position data of the determined second and third update points are stored in the data memory 51 at a step 120. Then, the second and third update points determined in the preceding steps are checked against the navigation end point to see whether either of the second or third update point determined at the step 118 is the navigation end point. If NO, process control passes to a step 124 in which the third update point is taken as the first update point for the next cycle of execution of the steps 108 to 122. On the other hand, if one of the second and third update points is the navigation end point, control returns to the routine of FIG. 4.

Detailed Description Paragraph Right (25):
Therefore, by repeating the steps 108 to 124, all of the update points along the route are found and recorded in the data memory 51.

Detailed Description Paragraph Right (26):
After completing the sub-routine of FIG. 9, navigational guidance to the navigation

start point is provided by the sub-routine illustrated in FIG. 12. During vehicle travel, travel distance .intg..DELTA.D and instantaneous vehicle position are derived and updated periodically. In practice, the travel distance and the instantaneous vehicle position are updated after every given distance of vehicle travel. As stated previously, the vehicle travel distance is monitored by the travel distance sensor 25 which produces the travel distance indicative pulse per given unit distance of travel of the vehicle. Therefore, by counting the vehicle travel distance indicative pulses from the travel distance sensor 25, the travel distance can be monitored. The vehicle travel distance .intg..DELTA.D and the instantaneous vehicle position (x, y) are derived by an interrupt routine shown in FIG. 13. As will be appreciated, the interrupt routine of FIG. 13 is triggered at every given distance .DELTA.D of vehicle travel.

Detailed Description Paragraph Right (27):
In the interrupt routine of FIG. 13, the travel distance .intg..DELTA.D is updated by adding .DELTA.D to the existing value, at a step 140, and the direction of vehicle travel .theta. over the last unit of distance .DELTA.D is read out. Then the distances travelled along the coordinate axes .DELTA.x and .DELTA.y from the first update point are updated according to the following equations:

Detailed Description Paragraph Right (28):
where x.sub.1 and y.sub.1 represent the coordinates of the first update point from which the vehicle travels to the second update point.

Detailed Description Paragraph Right (29):
In the step 142, the vehicle symbol is moved to the point (x, y). Control then returns to the navigation program.

Detailed Description Paragraph Right (30):
The sub-routine of FIG. 12 first checks whether input of the starting point was performed in precise data entry mode or the rough data entry mode, at a step 130. If the starting point was selected by means of the precise data entry mode, then normal navigation process starts. Thus, at a step 132, the appropriate block of the road map and the selected route are displayed on the display screen 37. On the other hand, if the starting point was selected by rough data entry, a larger-scale road map including the initial individual unit area is displayed on the display screen at a step 132 as shown in FIG. 10. Then, a directional guidance inset B is displayed in one corner of the display screen at a step 134. An arrow points in the suggested direction of travel to the navigation start point Z.sub.a, as shown in FIG. 11.

Detailed Description Paragraph Right (31):
After the step 132 or 134, control returns to the routine of FIG. 4. Immediately after returning from the sub-routine of FIG. 12, the vehicle position is checked to see if the vehicle has reached the navigation start point or not at a step 128 of FIG. 4. If the vehicle has not yet reached the navigation start point, control returns to the step 126 to re-execute the sub-routine of FIG. 12. On the other hand, once the vehicle reaches the navigation start point, the vehicle position coordinates are set equal to those of the navigation start point (x.sub.0, y.sub.0) and a first travel zone is set up using the navigation start point as the first update point, at a step 129.

Detailed Description Paragraph Right (32):
At subsequent step 230 in FIG. 14, an update zone which extends a given distance from the second update point (x.sub.1, y.sub.1) is also derived, in a manner shown in FIG. 15. As shown in FIG. 15, the configuration of the update zone varies with the relationship between the entry direction .theta..sub.in and the exit direction .theta..sub.out. For instance, when the preset route through the second update point is straight, the update zone around the second update zone is essentially an elongated rectangle with its major axis perpendicular to the axis of the preset route at the second update point, as represented by the reference numeral Z.sub.200. On the other hand, when the preset route requires a turn or a change in travel direction at the second update point, the update zone will be a circle centered on the second update point, as represented by the reference numeral Z.sub.202. The configuration of the update zone also varies with the distance D between the first and second update points.

Detailed Description Paragraph Right (33):
The configuration of the rectangular update zone is defined by the intersection of a circle and an elongated rectangle, both centered on the second update point (x.sub.1, y.sub.1). The radius of the circle about the second update point is 0.1D. The minor axis of the rectangle is 0.06D centered on the second update point and its major axis is longer than the radius of the circle. This figure is actually the geometric result of two criteria for recognizing that the vehicle position approximately coincides with the second update point, namely,

Detailed Description Paragraph Right (34):
(1) that the current detected vehicle position is within 0.1D of the second update point; and,

Detailed Description Paragraph Right (35):
(2) that the total travel distance .intg..DELTA.D is within .+-.0.03D of the known distance between update points in question. Note that the relatively high accuracy of the travel distance is reflected in the 0.03D value and the relatively low directional accuracy is reflected in the 0.1D value.

Detailed Description Paragraph Right (36):
On the other hand, if the update zone is of the circular form, the radius thereof is 0.1D about the second update point (x.sub.1, y.sub.1).

Detailed Description Paragraph Right (37):
An error zone Z.sub.204 or Z.sub.206 is also set up in step 230. The error zone is in the form of a rectangle extending from the first update point or the starting point to the next update point. In addition, the longitudinal ends of the rectangle are defined by circles of radius 1.1D centered on the two update points. The rectangle is 0.5D wide, so that the error zone covers a corridor 0.25D to either side of the line connecting the update points and extending about 0.1D past both update points. Note that this area covers the update zone completely. Furthermore, the route followed by the vehicle cannot deviate by more than 0.25D from the straight-line path- this imposes a need for extra preset update points on especially circuitous roads.

Detailed Description Paragraph Right (38):
At a step 240, the map and the vehicle position symbol are displayed on the display screen 37 so as to renew the display for the next update point. Then, at a step 250, the program checks to see whether or not the next update point is the one closest to the destination. The update point closest to the destination will be referred to as the "final update point". If the next update point is the final update point, a message "APPROACHING DESTINATION" is displayed on the display screen 37. In either case, at a step 270, the preset route is checked to see of the vehicle is to pass straight through the update point rather than turning.

Detailed Description Paragraph Right (39):
If the vehicle is to pass straight through the update point, a flat FLG is reset at a step 280. Otherwise control passes to a step 400 which will be discussed later. After the flag FLG is reset at the step 280, the program checks to see if the vehicle is in the update zone, at a step 290. If the vehicle is in the update zone, control passes to a step 300; otherwise the program goes to a step 350.

Detailed Description Paragraph Right (40):
At the step 300 in FIG. 18, the distance .intg..DELTA.D travelled since the last update point is compared with the known distance D between the two updating points. If the measured distance .intg..DELTA.D matches the known distance D, when checked at the step 300, control passes to a step 320 in which the vehicle position coordinates (x, y) are replaced by the coordinates (x.sub.1, y.sub.1) of the current update point. Thereafter, at a step 330, the travel distance .intg..DELTA.D between the update points is rest to zero. Then, data identifying the current pair of update points is updated so as to point to the next stretch of the preset route at a step 340. Thereafter, control returns to the step 230.

Detailed Description Paragraph Right (41):
On the other hand, if the difference between the measured distance .intg..DELTA.D and the known distance D is other than zero at step 300, the flag FLG is set at a step

310. The distance l between the update point (x.sub.1, y.sub.1) and the instantaneous vehicle position (x, y) is derived according to the following formula, at a step 313:

Detailed Description Paragraph Right (42):
If the vehicle is outside of the update zone at step 290 then the flag FLG is checked at a step 350. If the flag FLG is set, the stored data indicative of the distance l are checked to find the minimum value, i.e. the closest approach to the update point, at a step 385. At the step 385, the coordinates (x.sub.l, y.sub.l) of the vehicle position at which the minimum distance l is obtained are read out. At steps 390 and 395, the vehicle position coordinates are adjusted to approximate the correct position. This adjustment is based on the assumptions that the closest approach (x.sub.l, y.sub.l) was in fact the update point (x.sub.1, y.sub.1) and that the vehicle is now 0.03D past the update point. The new coordinates are given by the following equations:

Detailed Description Paragraph Right (43):
If the flag FLG is not set when checked at the step 350, the program checks to see whether the vehicle is in the rror zone, at a step 360. If NO, i.e., if the vehicle is outside of the error zone, the message "OFF COURSE" is displayed on the display screen, at a step 370 and the program ends. On the other hand, if the vehicle is still within the error zone, the program checks the CLEAR key in the switch-key array 41, at a step 380. If the CLEAR key has been depressed at the step 380, control returns to the initializing step 100. Otherwise, control passes to the step 290.

Detailed Description Paragraph Right (44):
If the vehicle is to change direction significantly (step 270), control passes to a step 400 at FIG. 19, which checks to see if the vehicle is in the update zone. If so, at step 410 the planned route through the current update point is displayed graphically on the screen to aid the driver at this crucial point. The display image generated at the step 410 includes a number of indicator segments, each indicative of a given distance of vehicle travel arranged along the route in both entry and exit directions. After the step 410, one of the sub-routines as shown in FIGS. 20 and 21 is executed.

Detailed Description Paragraph Right (47):
The sub-routine of FIG. 20 is triggered when the vehicle enters the circular update zone B. At a step 810, the difference between the measured travel distance .intg..DELTA.D and the known distance D between the update points is derived. The obtained difference is subtracted from the radius 0.1D of the circular update zone, and the absolute value of this result is divided by the known distance value D to derive an error rate value .epsilon.. This error rate .epsilon. is representative of the error between the known distance and the measured distance due possibly to errors in either the map data or in the measurement of the travel distance by the distance sensor 25. A small error rate means that the measured travel distance .intg..DELTA.D will tend to match the known distance D. On the other hand, a large error rate means that the travel distance value .intg..DELTA.D will differ significantly from the known distance.

Detailed Description Paragraph Right (48):
As the error rate increses, the update zone, within which the vehicle driving direction is monitored and compared with the update direction in order to detect when the vehicle reaches the updating point, must widen so as to allow for greater error. Accordingly, a circular update zone C of variable radius is set up at a step 820. The radius of the update zone C is derived from the following formula:

Detailed Description Paragraph Right (49):
If the vehicle is outside of the update zone C when checked at the step 840, then distance indicator segments on the display screen 37 are turned OFF one-by-one at given intervals of vehicle travel at a step 850.

Detailed Description Paragraph Right (51):
Once the vehicle travel direction matches the update direction when checked at the step 880, the display on the display screen 37 is normalized at a step 885. Thereafter, the vehicle position data (x.sub.0, y.sub.0) are replaced by the position data (x.sub.1, y.sub.1) of the update point the vehicle just reached, at a step 480 of

FIG. 19. Thereafter, the travel distance .intg..DELTA.D is reset to zero, at a step 490. Then, control returns to the step 340 of FIG. 18 to repeat the navigation process for the next preset update point.

Detailed Description Paragraph Right (52):
FIG. 21 shows a modification to the sub-routine of FIG. 20. As in the sub-routine of FIG. 4, the error rate .epsilon. is derived at a step 910. The derived error rate .epsilon. is compared with a reference value .delta. at a step 920. If the error rate .epsilon. is equal to or less than the reference value .delta., the program goes to a step 930, in which the difference between the travel distance .intg..DELTA.D and the known distance D between the update points is compared with a predetermined distance value l.sub.ref at a step 930. If the difference (D-.intg..DELTA.D) is greater than the predetermined distance value l.sub.ref, then the distance indicator segments are turned OFF one-by-one per unit of distance travelled by the vehicle in a step 940.

Detailed Description Paragraph Right (53):
If the difference (D-.intg..DELTA.D) becomes equal to or less than the predetermined distance value l.sub.ref, the arrow symbol serving as the distance indicator segment blinks at a step 950. Thereafter, the vehicle direction of travel is read out at a step 960. The read direction of travel is compared with the update direction .theta..sub.r at a step 970. If the direction of travel does not match the update direction, a step 980 checks to see if the vehicle is within the fixed-radius update zone B. If the vehicle is still within the fixed-radius update zone, then control returns to the step 960; otherwise control returns to the step 370. On the other hand, if the direction of travel matches the update direction when checked at the step 970, the map display on the display screen 37 is normalized at a step 1045. Then, control passes to the step 480 of FIG. 4.

Detailed Description Paragraph Right (54):
If the error rate .delta. is greater than the reference value .delta. when checked at the step 920, then the distance d between the vehicle position (x, y) and the update point (x.sub.1, y.sub.1) is calculated at a step 990. At a step 1000, the distance indicator segments are turned OFF one-by-one for each given unit of vehicle travel. Then, the distance d derived at the step 990 is compared with the predetermined distance value l.sub.ref, at a step 1010. If the distance d is equal to or less than the predetermined distance value l.sub.ref, the arrow symbol blinks at a step 1020. Otherwise, the update direction .theta..sub.r is read out at a step 1030. The vehicle direction is compared with the updating direction in a step 1040, which is identical to step 970 except that control passes to step 1050 if the two directions do not match. Similarly, step 1050 is identical to step 980 except that control returns to step 990 if the vehicle is still within the fixed-radius update zone B.

Detailed Description Paragraph Right (55):
In the preferred embodiment, after the step 370, a routine shown in FIG. 22 is triggered to guide the vehicle back to the preset route. The routine of FIG. 22 first displays the preset route on the map at a step 1102. Thereafter, the update point through which the vehicle last passed before going off course is highlighted on the display at a step 1104. The symbol of the vehicle position will be simultaneously displayed on the display screen 37. Presumably, the vehicle is than driven back to the preset route. During this travel, the number of known target points through which the vehicle passes on the way back to the preset route is counted. This count N of target points is compared with a given value, e.g. 11, at a step 1106. If the count N is equal to or greater than the given value, control passes to a step 1108 in which the message "OFF COURSE, PLEASE REENTER CURRENT POSITION" is displayed to request reentry of the current vehicle position data, in the manner shown in FIG. 21. Then, the navigation program returns to the step 102.

Detailed Description Paragraph Right (56):
On the other hand, as long as fewer than 11 target points have been passed, control passes to a step 1110. At step 1110, the distance from the current vehicle position to the last update point is checked. Once the vehicle approaches to within 200 m of the update point, for example, then normal navigation can resume from step 1112.

Detailed Description Paragraph Right (57):
FIGS. 24 to 26 show another embodiment of the navigation process to be implemented by

the preferred navigation system. The process of guiding the vehicle to the navigation start point can be substantially the same as in the previous embodiments. Alternatively, navigation process can be triggered by depressing a START switch in the key-switch array 41 of the input unit 29. Then, the navigation start position is recognized to be the instantaneous position when the START switch is depressed at a step 1202 in FIG. 24. This is used to set up the first travel zone at a step 1204. Then, the road map display starts at a step 1206. A trace of the vehicle position since the last update point is superimposed on the displayed map at a step 1208. The current vehicle position is monitored in substantially the same way as disclosed with respect to the previous embodiments. Step 1210 checks to see if the vehicle has reached the update zone. If not, control returns to step 1206. Otherwise, the program moves to the larger-scale map display in step 1212 and then executes one of the subroutines of FIGS. 20 and 21, in a step 1213. Thereafter, once the vehicle reaches the update point, the vehicle position trace is redrawn between the two update points at a step 1214. The subsequent step 1216 checks to see if that update point was the navigation end point. If not, the travel zone is renewed by taking the second update point in the preceding travel zone as the new first update point at a step 1218.

Detailed Description Paragraph Right (58):
As shown in FIG. 25, when moving to a new travel zone, the travel distance data .intg..DELTA.D is reset to zero or a given value e.g. 0.03D. At the same time, the vehicle trace on the display screen 37 is cleared and restarted from the update point Z.sub.1. Thus, the vehicle position trace always starts from the first update zone of the current travel zone and is redrawn each time the vehicle reaches the second update point of the current travel zone.

Detailed Description Paragraph Right (59):
FIG. 26, shows the step 1214, in which the vehicle trace is redrawn on the display screen 37, in more detail. First, at a step 1302, the vehicle trace through the former travel zone is erased. Thereafter, the route from Z.sub.0 to Z.sub.1, i.e. the former travel zone, is highlighted as the vehicle trace through the former travel zone.

Detailed Description Paragraph Left (2):
At a step 316, the calculated distance l and the instantaneous vehicle position coordinates (x, y) are stored for later reference. Then control returns to the step 290. The steps 290, 300, 310, 313 and 316 are repeated until the vehicle leaves the update zone or the difference between the calculated distance .intg..DELTA.D and the known distance D reaches zero when checked at the step 300, i.e. until the vehicle reaches the update point.

Detailed Description Paragraph Left (4):
Therefore, when the error rate .delta. is small, the radius R.sub.c of the update zone C will also be small. On the other hand, when the error rate .delta. is large, so is the radius R.sub.c of the update zone C. The minimum and maximum radii of the update zone C are limited respectively to 100 m and 0.1D which corresponds to the radius of the fixed radius update zone set up in step 230. Using the radius R.sub.c determined at the step 820, the update zone C is defined to be centered on the update point (x.sub.1, y.sub.1), at a step 830. After this, the vehicle position (x, y) is checked at a step 840 to see if the vehicle is within the update zone C.

CLAIMS:

1. A navigation system for an automotive vehicle comprising:

first means for monitoring vehicle motion and deriving first data indicative of vehicle travelling data;

second means for storing a map which is separated into a plurality of blocks and includes a plurality of known points;

third means for entry of position data of at least a start point and a destination;

fourth means operable for selection of a route for the vehicle and storing the selected route, said fourth means storing second data indicative of a navigation start point, a navigation end point, designated known points along said route and between

said navigation start point and said navigation end point, and a predetermined condition for detecting when the vehicle reaches each of said designated known points, said fourth means determining one of the known points closest to the start point as said navigation start point and another of the known points closest to the destination as said navigation end point by searching said known points within a search area which is expandable in a limited direction determined based on a direction of a straight line extending through the start point and the destination;

fifth means for displaying said map stored in said second means, and a symbol representing a vehicle position; and

sixth means for setting a travel zone between successive designated known points and displaying instantaneous position of said vehicle, said sixth means further operable for:

monitoring said vehicle position within said travel zone;

detecting when said predetermined condition is satisfied; and,

in such cases, setting a successive travel zone.

2. A navigation system as set forth in claim 1, wherein said fourth means determines said limited expanding direction of said search area by dividing a coordinate system into a plurality of sectors and selecting one of said sectors including said direction along which said straight line lies.

3. A navigation system as set forth in claim 2, wherein said fourth means expands said search area in an iterative fashion whenever no known point is found in said search area.

4. A navigation system as set forth in claim 3, wherein said sixth means detects the approach of the vehicle to a next designated known point on the basis of said first data, detects when the distance from the vehicle position to said next designated known point is less than a given distance, thus defining an area centered at said next designated known point, detects when the vehicle enters said defined area and checks said second data against a given direction so as to detect when vehicle travel direction matches said given direction, thereby detecting when said predetermined condition is satisfied, and that the vehicle has reached said next designated known point.

5. A navigation system as set forth in claim 3, wherein said sixth means derives a distance of travel from a starting designated known point, detects the approach of the vehicle to a next designated known point on the basis of said first data, and detects when the distance from the vehicle position to said next designated known point is less than a given distance, thereby defining an area centered at said next designated known point, detects when the vehicle enters said defined area and compares said derived travel distance with a known distance between said designated known points, thereby detecting when said predetermined condition is satisfied, and thereby detecting that the vehicle has reached said next designated known point.

7. A navigation system as set forth in claim 4, wherein said first means replaces said first data indicative of vehicle position with position data for said next designated known point when said sixth means detects that the vehicle has reached said next designated known point.

8. A navigation system as set forth in claim 5, wherein said first means replaces said first data indicative of vehicle position with position data for said next designated known point when said sixth means detects that the vehicle has reached said next designated known point.

9. A navigation system as set forth in claim 8, wherein said first means replaces said first data with the position data of said next designated known point when the travel distance derived by said sixth means matches the known distance between the two designated points at least within said defined area, in cases where vehicle travel directions approaching and leaving said next designated known point are approximately

equal.

10. A navigation system as set forth in claim 9, wherein said sixth means defines said defined area as a circular area of variable radius related to an error value when said approaching direction and leaving direction are different, and as an elongated area having a minor axis parallel to the vehicle travel direction, and a major axis perpendicular to said vehicle travel direction.

11. A navigation system as set forth in claim 10, wherein said first means replaces said first data with the position data of said next designated known point when the vehicle travel distance from a former designated known point is less than said known distance between said two designated known points when the vehicle exits a distal side of said elongated area.

12. A navigation system as set forth in claim 11, wherein said sixth means defines a new travel zone whenever said first data is replaced with the position data for said next designated known point.

13. A navigation system for an automotive vehicle comprising:

a map memory storing a road map which is divided into a plurality of pages further subdivided into contiguous blocks, said map memory also storing identification data for the blocks and index data for various points within the map blocks, which index data includes position data for a plurality of known points;

an input unit for entry of the identification data for a map memory block and the index data for known points;

a display unit for displaying on a display screen a map block based on said identification data;

a processor accepting entry of the index data for a travel starting point and a destination through the input unit, searching for the map blocks containing the designated known points based on said entered data, said processor progressively expanding the search area along a vector between the travel starting point and the destination, said processor finding the known point closest to the travel starting point and the other known point closest to the destination along the vector and storing these known points as the navigation start point and the navigation end point, and said processor further determining a route between said navigation start point and said navigation end point.

14. A process for navigation of a vehicle along a preset route comprising the steps of:

providing a road map which is divided into a plurality of map blocks and including data for a plurality of known points on a map;

providing input data defining a start point and a destination;

displaying said road map on a visual display screen;

searching in a given search area for finding known points which are closest to said start point and said destination for designation as a navigation start point and a navigation end point, said given search area originally corresponding to an area of said map blocks including said start point and said destination and progressively expanding in a limited direction which is determined based on a direction between said start point and said destination;

presetting a route between said navigation start point and said navigation end point across said map and designating known points along the preset route;

defining a travel zone between a first starting designated known point and a second designated known point along said route;

monitoring vehicle travel distance within said travel zone and detecting when the

vehicle approaches to within a first given area of said second designated known point;

displaying a symbol indicative of the instantaneous vehicle position through said travel zone;

monitoring vehicle travel within said first given area for comparison with a predetermined criterion for detecting when the vehicle coincides with said second designated known point;

shifting a vehicle position indicative symbol to said designated known point on the display; and

redefining said travel zone by taking the second designated known point which currently coincides with said vehicle as said first designated known point and selecting a neighboring designated known point as said second designated known point.

21. A method of finding a connected path, in a feld of points of known positions, between designated start and end points, comprising the steps of storing the points of known position in a memory, and:

(a) tesselating said field into a plurality of blocks;

(b) sectoring said field about said start point;

(c) identifying a target sector in which lies a straightline vector from said start point to said end point;

(d) defining a search area, initially enclosing only the block in which said start point lies;

(e) checking said search area for the presence of at least one of said points of known positions;

(f) if none of said points of known position is found in step (e), expanding said search area to include blocks adjoining blocks already in said search area and lying at least in part within said target sector;

(g) repeating steps (e) and (f) until at least one of said points is found in step (e);

(h) defining the point found in step (a) as said start point;

(i) repeating steps (d) through (g) in the order listed to determine said end point; and

(j) electronically generating said connected path based on the start and end points found in steps (h) and (i).

22. The method of claim 21, wherein the step (h) further comprises the steps of finding which of the points found in step (e) lies closest to said start point, in cases where more than one point is found in step (e).

23. The method of claim 21 wherein said generating step comprises generating a display of at least one search area including therein a display of a position of a vehicle travelling between said start and end points.

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L11: Entry 27 of 86 File: USPT May 29, 2001

DOCUMENT-IDENTIFIER: US 6240361 B1
TITLE: Navigation apparatus

Abstract Paragraph Left (1):
A navigation apparatus includes a display unit for displaying a map and a cursor, and a scrolling unit for scrolling the map displayed on the display unit. The navigation apparatus also has a place-name-display control unit for displaying on the display unit, when scrolling is performed, the place name corresponding to the position of the cursor on the map displayed on the display unit.

Brief Summary Paragraph Right (2):
The present invention relates to a navigation apparatus in which a map and a cursor are displayed on display means and the map displayed on the display means is scrolled.

Brief Summary Paragraph Right (4):
FIG. 7 illustrates the operation for setting the destination in a conventional navigation apparatus.

Brief Summary Paragraph Right (5):
The mark of an operator's vehicle location and a map in the vicinity of the location where the operator's vehicle is positioned are displayed on a display unit (display) (S31). To indicate the destination on the display unit, a joystick is leaned in a direction in which the map is to be scrolled and the map on the display unit is scrolled (S32). During scrolling, when the destination is indicated on the display unit and it is shown at the cursor, the joystick is pressed (a destination-decision button is pressed) (S33) to set the destination and to indicate information related to the set destination on the display unit (S34). For example, information such as the address of the destination and a facility name at the destination is indicated.

Brief Summary Paragraph Right (6):
If scrolling is not continued, the address and the facility name are indicated. When scrolling is continued (S35), the address and the facility name being indicated are deleted (S36), and scrolling is performed (S32). During scrolling, when a new destination is indicated on the display unit and it is shown at the cursor, the joystick is pressed (the destination-decision button is pressed) (S33) to set the destination again and to indicate information related to the set destination, such as the address of the set destination and a facility name at the destination, on the display unit (S34).

Brief Summary Paragraph Right (7):
As described above, the map is scrolled and when the cursor on the display unit is positioned on the destination, the destination-decision button is pressed. The destination setting operation is completed and the address of the destination and a facility name at the destination are indicated. It can be confirmed that the set destination is the desired one.

Brief Summary Paragraph Right (8):
In the above conventional apparatus, the address or the facility name cannot be indicated unless a destination setting operation is performed. To obtain information as to a new place other than the set destination, such as the address thereof and a facility name at the place, it is necessary to perform the same destination setting

operation. In other words, the map is scrolled so that the new place is indicated at the cursor (S35, S36, S32), and when the new place is indicated at the cursor, the destination-decision button needs to be pressed (S33). A troublesome operation of pressing the destination-decision button is required to indicate the address of the destination and a facility name at the destination.

Brief Summary Paragraph Right (9):
When a place other than the destination is displayed on the display unit, if the displayed place is strange to an operator, the operator cannot identify the place. In this case, the operator cannot know which place is being displayed unless the destination-decision button is pressed.

Brief Summary Paragraph Right (10):
When the map displayed on the display unit is scrolled to show a place other than that in which the operator's vehicle is included, if the operator does not know the location of the map which is currently displayed, the operator cannot recognize the relationship between the location of the map being displayed and the operator's vehicle location.

Brief Summary Paragraph Right (11):
Accordingly, an object of the present invention is to provide a navigation apparatus which can indicate the address of or a facility name at the location displayed at the cursor when the map is scrolled, without performing a troublesome operation such as pressing a destination-decision button.

Brief Summary Paragraph Right (12):
Another object of the present invention is to provide a navigation apparatus which allows the operator to easily recognize the relationship between the location of the map currently being displayed and the operator's vehicle location when the map displayed on a display unit is scrolled to show a map other than that in which the operator's vehicle location is included.

Brief Summary Paragraph Right (13):
One of the foregoing objects is achieved in one aspect of the present invention through the provision of a navigation apparatus including: display means for displaying a map and a cursor; scrolling means for scrolling the map displayed on the display means; and place name-display control means for displaying on the display means the place name corresponding to the position of the cursor on the map displayed on the display means, when scrolling is performed.

Brief Summary Paragraph Right (14):
According to the present invention, when a map is scrolled, the address of and a facility name at the location corresponding to the cursor can be displayed without performing a troublesome operation, such as pressing a destination-decision button.

Brief Summary Paragraph Right (15):
One of the foregoing objects is achieved in another aspect of the present invention through the provision of a navigation apparatus including: display means for displaying a map and a cursor; scrolling means for scrolling the map displayed on the display means; and direction-display control means for displaying on the display means the direction viewed from the operator's vehicle location or the specified location to the location corresponding to the cursor displayed on the display means.

Brief Summary Paragraph Right (16):
According to the present invention, when the map displayed on the display unit is scrolled to show a map which does not include the operator's vehicle location, the operator can easily recognize the relationship between the currently displayed map and the operator's vehicle location.

Brief Summary Paragraph Right (17):
One of the foregoing objects is achieved in still another aspects of the present invention through the provision of a navigation apparatus including: display means for displaying a map and a cursor; place-name-display control means for displaying on the display means the place name of the location on the map corresponding to the cursor displayed on the display means; and display-place-name changing means for changing the

place name of the location on the map corresponding to the cursor according to the scale of the map displayed on the display means.

Brief Summary Paragraph Right (18):
According to the present invention, the place name of the location on a map corresponding to the cursor can be appropriately displayed as a country name, a prefecture name, a city or town name, or a house number according to the scale of the map displayed on the display means.

Brief Summary Paragraph Right (19):
One of the foregoing objects is achieved in yet another aspect of the present invention through the provision of a navigation apparatus including: display means for displaying a map and a cursor; scrolling means for scrolling the map displayed on the display means; a database in which a location on the map corresponds to its name; and display control means for displaying on the display means, when a specified time period elapses after the map displayed on the display means is scrolled and scrolling is stopped, the name of the location corresponding to the cursor on the map displayed on the display means.

Brief Summary Paragraph Right (20):
According to the present invention, when a map is scrolled, a facility name at the location corresponding to the cursor can be displayed without performing a troublesome operation, such as pressing a destination-decision button.

Brief Summary Paragraph Right (21):
One of the foregoing objects is achieved in a further aspect of the present invention through the provision of a navigation apparatus including: display means for displaying a map and a cursor; a database in which a location on the map corresponds to its river name, its sea name, its mountain name, or its lake name; and display control means for displaying on the display means the river name, the sea name, the mountain name, or the lake name of the location corresponding to the cursor on the map displayed on the display means.

Drawing Description Paragraph Right (1):
FIG. 1 is a block diagram of a navigation apparatus NS1 according to the present invention.

Drawing Description Paragraph Right (4):
FIG. 4 is a view of a screen in a display unit 2 in an operation performed according to the flowchart shown in FIG. 3.

Drawing Description Paragraph Right (7):
FIG. 7 is a view showing the operation for setting the destination in a conventional navigation apparatus.

Detailed Description Paragraph Right (1):
FIG. 1 is a block diagram of a navigation apparatus NS1 according to the present invention.

Detailed Description Paragraph Right (2):
The navigation apparatus NS1 includes an input unit 1, a display unit 2, a CD-ROM 3, a GPS receiver 4, a beacon receiver 5, a RAM 6, a gyroscope 7, a vehicle-speed-pulse detector 8, a ROM 9, a CPU 10, a remote-control receiver 20, and a remote controller 30.

Detailed Description Paragraph Right (3):
The CPU 10 displays a map in the vicinity of the current location of a vehicle, a guided path from the starting point to the destination, a mark of the operator's vehicle location, a cursor, and other pieces of guide information on the display unit 2.

Detailed Description Paragraph Right (4):
The input unit 1 serves as a means for inputting the destination. The display unit 2 is formed of a liquid crystal display and shows a map, the cursor, a guided path, and various menus. The CD-ROM 3 is a memory which stores map data formed of a road layer,

a background layer, a character and symbol layer for each scale, and serves as a database in which a location on a map corresponds to its place name. Place names indicated on the display means include country name, a prefecture name, a city and town name, and house number.

Detailed Description Paragraph Right (5):
The GPS receiver 4 detects the current location of the vehicle, the direction in which the vehicle travels, and the vehicle speed with the use of satellite navigation. The beacon receiver 5 receives light beacon or radio beacon output from a transmitter provided along a road. The light beacon and the radio beacon are used for sending traffic information within a small area and can supply relatively detailed traffic information. The RAM 6 is a memory for temporarily storing specified data. The gyroscope 7 detects the rotation angle of the vehicle. The vehicle-speed-pulse detector 8 detects a vehicle-speed pulse generated during the movement of the vehicle. The ROM 9 stores the programs corresponding to the flowcharts shown in FIGS. 3 and 5.

Detailed Description Paragraph Right (6):
The remote controller 30 includes a joystick key 31, an enlargement key 32 for displaying a detailed-level map, a reduction key 33 for displaying a large-area map, a menu key 34 for displaying a menu, a position key 35 for displaying a map which includes the operator's vehicle location, together with the operators vehicle location mark, and a power key 36. The enlargement key 32 and the reduction key 33 serve as scale-changing means for changing the scale of a map displayed on the display means.

Detailed Description Paragraph Right (7):
The joystick key 31 is depressed in order to move the cursor relative to the map in one of eight directions, to move a menu selection bar right and left or up and down to select the desired menu item, to input the location specified by the cursor on a map, or to select the menu.

Detailed Description Paragraph Right (8):
The CPU 10 serves as a scrolling means for scrolling the map displayed on the display means. It also serves as place-name-display control means for showing on the display means the place name corresponding to the cursor position on the map displayed on the display means, when the map is scrolled. The CPU 10 yet also serves as display-place-name changing means for changing the place name to be displayed, according to the cursor position which changes as the map is scrolled.

Detailed Description Paragraph Right (10):
As shown in FIG. 2(1), a map around the operator's vehicle location and the mark of the operator's vehicle location are displayed on the display unit 2.

Detailed Description Paragraph Right (11):
At this state, the map displayed on the display unit 2 is scrolled. With this scrolling, the map displayed on the display unit 2 changes, and the place name of the position on the map corresponding to the cursor position indicated at the center of the display unit 2 is shown. In this case, since the location on the map corresponding to the cursor position changes by scrolling, the place name corresponding to the cursor position also changes as the location on the map changes.

Detailed Description Paragraph Right (12):
As shown in FIG. 2(2), the place name of the location on the map corresponding to the cursor position is, for example, xx town, Iwaki city, Fukushima prefecture at a point in time during scrolling. Scrolling continues and at a next point in time, the place name of the location on the map corresponding to the cursor position is changed to, for example, xx town, Kouriyama city, Fukushima prefecture as shown in FIG. 2(3). When scrolling continues further, the place name of the location on the map corresponding to the cursor position is changed again. This operation is repeated.

Detailed Description Paragraph Right (13):
According to the first embodiment, even if a troublesome operation, such as pressing the destination-decision button, is not performed, the address of and a facility name at the location corresponding to the cursor position can be displayed just by scrolling. An operation for displaying a place name is very easy to perform.

Detailed Description Paragraph Right (15):
FIG. 4 is a view of a screen in the display unit 2 in an operation performed according to the flowchart shown in FIG. 3.

Detailed Description Paragraph Right (16):
A map around the operator's vehicle location is displayed on the display unit 2. When a scrolling button is pressed (S2), scrolling starts (S3). The distance in a straight line between the operator's vehicle location and the location corresponding to the cursor displayed at the screen center of the display unit 2 is calculated (S4). The direction from the operator's vehicle location to the location corresponding to the cursor displayed at the screen center of the display unit 2 is also obtained (S5).

Detailed Description Paragraph Right (17):
The scrolled map is displayed on the display unit 2(S6). Along with this map, the calculated straight-line distance and the obtained direction are displayed on the display unit (S7). FIG. 4 shows a screen example. The calculated distance is indicated, for example, at the bottom right of the display unit 2 as a distance indication 22 of, for example, 320 km. The obtained direction is indicated, for example, at the bottom right of the display unit 2 by a downward arrow 21.

Detailed Description Paragraph Right (18):
According to the second embodiment, when the. map displayed on the display unit is scrolled to show a map which does not include the operator's vehicle location, the operator can easily recognize the relationship between the currently displayed map and the operator's vehicle location.

Detailed Description Paragraph Right (19):
In FIG. 4, the arrow 21 indicates the downward direction. Therefore, the location corresponding to the cursor displayed at the screen center of the display unit 2 is at the south when viewed from the operator's vehicle location. To indicate a direction, a character, such as "South," "East," and "Northwest," may be used instead of the arrow in the second embodiment. A symbol or character indicating a direction and numerals indicating a straight-line distance may be shown at a position other than the right bottom of the display unit 2.

Detailed Description Paragraph Right (20):
In the second embodiment, the direction from the operator's vehicle location to the position currently displayed is indicated on the display means. Instead of the operator's vehicle location, a specified location may be used. In this case, the direction from the specified location to the currently displayed position is indicated on the display means. Also in the second embodiment, the straight-line distance between the operator's vehicle location to the currently displayed position is indicated on the display means. Instead of the operator's vehicle location, a specified location may be used. In this case, the straight-line distance between the specified location to the currently displayed position is indicated on the display means.

Detailed Description Paragraph Right (21):
In other words, the CPU 10 serves as direction-display control means for displaying on the display means the direction viewed from the operator's vehicle location or the specified location to the currently displayed position. The CPU 10 also serves as straight-line-distance-display control means for displaying on the display means the straight-line distance from the operator's vehicle location or the specified location to the currently displayed position.

Detailed Description Paragraph Right (23):
The location of the operator's vehicle is indicated (S11). When the scrolling button is switched on (S12), scrolling starts (S13) and the scale of the map currently displayed on the display unit 2 is checked (S14). When the scale is small, the name of the prefecture or the state which includes the location on the map corresponding to the cursor displayed at the center of the display unit 2 is indicated (S15). When the scale is intermediate, the name of the city or town which includes the location on the map corresponding to the cursor displayed at the center of the display unit 2 is indicated (S16). When the scale is large, the house number at the location on the map corresponding to the cursor displayed at the center of the display unit 2 is indicated

(S17).

Detailed Description Paragraph Right (24):
According to the third embodiment, the place name of the location on the map corresponding to the cursor is indicated appropriately as a country name, a prefecture name, a city or town name, or a house number, according to the scale of the map displayed on the display means.

Detailed Description Paragraph Right (25):
In other words, the CPU 10 serves as place-name-display control means for displaying on the display means the place name of the location on the map corresponding to the cursor displayed on the display means. The CPU 10 also serves as display-place-name changing means for changing the place name of the location on the map corresponding to the cursor according to the scale of the map displayed on the display means. In this case, the display-place-name changing means changes one of a country name, a prefecture name, a city or town name, and a house number to another according to the scale of the map displayed on the display means.

Detailed Description Paragraph Right (26):
Whether the scale is large, intermediate, or small may be determined in any way in the third embodiment. You may consider that a whole-country map is displayed if the scale is small, a detailed map is displayed if the scale is intermediate, a very fine map is displayed if the scale is large. It may be configured such that a country name is indicated in Europe if the scale is small.

Detailed Description Paragraph Right (27):
In FIG. 1, the CD-ROM 3 is a memory which stores map data formed of a road layer, a background layer, and a character and symbol layer for each scale, and serves as a database in which a location on a map corresponds to its name. The name indicated on display means includes at least one of an address, a place name, a facility name, a river name, a road name, a sea name, a mountain name, and a lake name.

Detailed Description Paragraph Right (29):
The CPU 10 serves as a scrolling means for scrolling the map displayed on the display means. It also serves as display control means for displaying on the display means, when a specified time period elapses after the map displayed on the display means is scrolled and scrolling is stopped, the name of the location corresponding to the cursor on the map displayed on the display means.

Detailed Description Paragraph Right (30):
The display control means displays the name to be displayed after the specified time period, only for a second specified time period.

Detailed Description Paragraph Right (32):
A mark of the operator's vehicle and a map in the vicinity of the location where the operator's vehicle is positioned are displayed on a display unit (display) 2 (S21). To indicate the destination on the display unit 2, a joystick (provided for the input unit 1) is leaned in a direction in which the map is to be scrolled, and the map on the display unit 2 is scrolled (S22). During scrolling, when the destination is shown on the display unit 2, the operator releases the joystick to stop scrolling. When a specified time period (for example, two seconds) elapses after scrolling is stopped (S23), the name of the location corresponding to the cursor on the map displayed on the display unit 2 is shown (S24). The name displayed on the display unit 2 can include an address, a place name, a facility name, a river name, a road name, a sea name, a mountain name, or a lake name at each location on the map.

Detailed Description Paragraph Right (33):
When a second specified time period (for example, 10 seconds) elapses after the name is displayed on the display unit 2 (S25), the name is deleted (S26). If scrolling is not specified (S27), the current condition is maintained. When scrolling is specified (S27), the map is scrolled (S22). During scrolling, when a destination is indicated on the display unit 2, the operator releases the joystick to stop scrolling. When the specified time period (for example, two seconds) elapses after scrolling is stopped (S23), the name of the location corresponding to the cursor on the map displayed on the display unit 2 is shown (S24). The name remains indicated on the display unit 2,

for example, for 10 seconds (S25).

Detailed Description Paragraph Right (34):
According to the fourth embodiment, even if a troublesome operation, such as pressing a destination-decision button, is not performed, because a facility name at the location corresponding to the cursor on a map displayed on the display unit 2 can be shown when the map is scrolled, the displayed location can be easily identified.

Detailed Description Paragraph Right (35):
In the fourth embodiment, the navigation apparatus includes display means for displaying a map and a cursor; a database in which a location on the map corresponds to its river name, its sea name, its mountain name, or its lake name; and display control means for displaying on the display means the river name, the sea name, the mountain name, or the lake name of the location corresponding to the cursor on the map displayed on the display means. When the river name, the sea name, the mountain name, or the lake name of the location corresponding to the cursor on the map is indicated as described above, it is easier to identify the displayed location than when only a road name and an address are indicated.

Detailed Description Paragraph Left (1):
(a) Configuration of Navigation Apparatus

Detailed Description Paragraph Left (2):
Place-name-display Processing in the First Embodiment

Detailed Description Paragraph Left (3):
(a) Distance and Direction Display Processing in a Second Embodiment

Detailed Description Paragraph Left (4):
(a) Place-name-display Processing in a Third Embodiment

Detailed Description Paragraph Left (6):
(b) Name-display Processing in the Fourth Embodiment

CLAIMS:

1. A navigation apparatus comprising:

display means for displaying a map and a cursor;

scrolling means for scrolling the map displayed on said display means; and

place-name-display control means for displaying on said display means the place name corresponding to the position of the cursor on the map displayed on said display means, when a specified time period elapses after the map displayed on said display means is scrolled and scrolling is stopped.

2. A navigation apparatus according to claim 1, further comprising display-place-name changing means for changing the place name to be displayed, according to the cursor position changed by scrolling.

3. A navigation apparatus according to claim 1, wherein the place name displayed on said display means includes a facility name.

4. A navigation apparatus according to claim 1, wherein the cursor displayed on said display means is always shown substantially at the center of a screen when the map is scrolled.

5. A navigation apparatus comprising:

display means for displaying a map and a cursor;

scrolling means for scrolling the map displayed on said display means; and

direction-display control means for displaying on said display means the direction

viewed from a chosen position of either the operator's vehicle location or a specified location to the location corresponding to the cursor displayed on said display means, at least when the displayed map does not include the chosen position.

6. A navigation apparatus according to claim 5, wherein the direction shown on said display means is indicated by an arrow.

7. A navigation apparatus according to claim 5, wherein the direction shown on said display means is indicated by a character.

8. A navigation apparatus according to claim 5, further comprising straight-line-distance-display control means for displaying on said display means the straight-line distance between a chosen position of either the operator's vehicle location or the specified location and the currently displayed location.

9. A navigation apparatus according to claim 5, wherein the cursor displayed on said display means is always shown substantially at the center of a screen when the map is scrolled.

10. A navigation apparatus comprising:

display means for displaying a map and a cursor;

scrolling means for scrolling the map displayed on said display means;

place-name-display control means for displaying on said display means the place name of the location on the map corresponding to the cursor displayed on said display means, when a specified time period elapses after the map displayed on said display means is scrolled and scrolling is stopped; and

display-place-name changing means for changing the place name of the location on the map corresponding to the cursor according to the scale of the map displayed on said display means.

11. A navigation apparatus according to claim 10, wherein said display-place-name changing means changes one of a country name, a state name, a city or town name, and a house number to another according to the scale of the map displayed on said display means.

12. A navigation apparatus according to claim 10, wherein the scale of the map displayed on said display means is changed by external input means.

13. A navigation apparatus comprising:

display means for displaying a map and a cursor;

scrolling means for scrolling the map displayed on said display means;

a database in which a location on the map corresponds to its name; and

display control means for displaying on said display means, when a specified time period elapses after the map displayed on said display means is scrolled and scrolling is stopped, the name of the location corresponding to the cursor on the map displayed on said display means.

14. A navigation apparatus according to claim 13, wherein the name displayed on said display means is one of an address, a place name, a facility name, a river name, a road name, a sea name, a mountain name, and a lake name.

15. A navigation apparatus according to claim 13, wherein said display control means displays the name to be displayed after the specified time period elapses, only for a second specified time period.

16. A navigation apparatus according to claim 13, wherein said display control means does not display the name when scrolling is again performed within the specified time

period.

17. A navigation apparatus according to claim 13, wherein the cursor displayed on said display means is always shown substantially at the center of a screen when the map is scrolled.

18. A navigation apparatus comprising:

display means for displaying a map and a cursor;

scrolling means for scrolling the map displayed on said display means;

a database in which a location on the map corresponds to its river name, its sea name, its mountain name, or its lake name; and

display control means for displaying on said display means the river name, the sea name, the mountain name, or the lake name of the location corresponding to the cursor on the map displayed on said display means, when a specified time period elapses after the map displayed on said display means is scrolled and scrolling is stopped.

19. A navigation apparatus according to claim 18, further comprising:

display-name changing means for changing the name to be displayed, according to the cursor position changed by scrolling.

20. A navigation apparatus according to claim 18, wherein the cursor displayed on said display means is always shown substantially at the center of a screen when the map is scrolled.

21. A method of operating a vehicle navigation apparatus including a display, comprising:

displaying a map and a cursor on the display;

scrolling the map; and

displaying an identification of the location on the map corresponding to the position of the cursor, when a specified time period elapses after the map displayed on said display is scrolled and scrolling is stopped.

22. A method of operating a vehicle navigation apparatus according to claim 21, wherein the displayed cursor is shown at a predetermined location on the display when the map is scrolled.

23. A method of operating a vehicle navigation apparatus according to claim 21, wherein the location identification is the name of the general geographic area corresponding to the position of the cursor.

24. A method of operating a vehicle navigation apparatus including a display, comprising;

displaying a map and a cursor on the display; and

displaying the direction from a specified location to the location on the map corresponding to the cursor, at least when the displayed map does not include the specified location.

25. A method of operating a vehicle navigation apparatus according to claim 24, wherein the specified location is the vehicle location.

26. A method of operating a vehicle navigation apparatus according to claim 24, wherein the direction is indicated by an arrow.

27. A method of operating a vehicle navigation apparatus according to claim 24 wherein the direction is indicated by characters.

28. A method of operating a vehicle navigation apparatus according to claim 24 further comprising displaying the distance between a specified location and the location on the map corresponding to the cursor.

29. A method of operating a vehicle navigation apparatus according to claim 28 wherein the specified location is the vehicle location.

30. A method of operating a vehicle navigation apparatus including a display and at least a larger scale map and a smaller scale map, comprising:

displaying a map of a specified scale and a cursor on the display;

scrolling the map; and

if the larger scale map is displayed, displaying a more specific identification of the location on the map corresponding to the position of the cursor, whereas it the smaller scale map is displayed, displaying a more general identification of the location on the map corresponding to the position of the cursor, where the identification is displayed after a specified time period elapses after the map displayed on the display is scrolled and scrolling is stopped.

31. A method of operating a vehicle navigation apparatus according to claim 30 including at least three maps, each map having a different scale ranging from smaller to larger, wherein the specificity of the identification of the location on a displayed map corresponding to the position of the cursor increases with increasing map scale.

32. A method of operating a vehicle navigation apparatus comprising:

displaying a map and a cursor on the display;

scrolling the map; and

when a specified time period elapses after scrolling of the map is stopped, displaying an identification of the location on the map corresponding to the position of the cursor.

33. A method of operating a vehicle navigation apparatus according to claim 32, wherein the location identification is displayed for a second specified time period.

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L11: Entry 43 of 86 File: USPT Jun 29, 1999

DOCUMENT-IDENTIFIER: US 5918180 A
TITLE: Telephone operable global tracking system for vehicles

Abstract Paragraph Left (1):
A tracking system for monitoring and locating vehicles includes a cellular telephone that is located in the vehicle, a global positioning system (GPS) receiver also located with the vehicle, and an interface unit between the global positioning receiver and the telephone. The global positioning receiver communicates with a system of satellites and provides continuous data, reflecting the present. spacial position of the vehicle in terms of its latitude/longitude coordinates. The interface between the GPS receiver and the wireless telephone includes a speech synthesizer circuit which converts the digitally encoded spacial coordinates into speech, which enunciates the position through the cellular telephone. By calling the vehicle cellular telephone from a remote location, the owner of the vehicle can hear the location of the vehicle, and then use that information to obtain its precise location.

Brief Summary Paragraph Right (9):
It is also an object of the present invention to provide a vehicle monitoring system that uses the vehicle's wireless telephone in conjunction with the known GPS system (Global Positioning System) which is presently operable throughout the World.

Brief Summary Paragraph Right (11):
The foregoing and other objects of the present invention are realized, in accordance with a first embodiment of the present invention with what the present inventor regards as a GTS, i.e. a Global Tracking System. The GTS essentially consists of a conventional car telephone which includes automatic answering capabilities and a conventional GPS (global positioning system) receiver. The GTS (global tracking system) of the present invention includes a special interface circuit for coupling the conventional telephone to the conventional GPS system to realize a remotely operable (off vehicle) vehicle tracking system. Essentially, the interface component of the GTS serves to convert conventional coordinate position data supplied by the GPS system into voice, i.e. spoken words, which are then played back and/or relayed back to the owner of the vehicle through the vehicle telephone. The owner can then consult look up tables which provide the exact location, e.g. city and cross streets, where the vehicle is currently located.

Brief Summary Paragraph Right (12):
In accordance with a more elaborate embodiment of the present invention, the interface includes a controller e.g., a microcomputer and circuitry for providing elaborate, multi-purpose interfacing between and among the vehicle's telephone, alarm system, ignition, lighting system etc. and the aforementioned global positioning system (GPS).

Brief Summary Paragraph Right (14):
The system of the present invention provides owners of vehicles with numerous other options and features including a navigation system which enables the driver to plot the vehicle ~~location~~ on an on-board computer-controlled map display, and an ability to enter a destination and obtain directions to that destination. Further, the invention includes ~~the~~ concept of connecting PCMCIA mapping software to the GTS unit, to provide exact mapping of a route via a look up table in the PCMCIA card. Thus, the invention also constitutes a global mapping system for vehicles, more sophisticated than the existing GPS system which only provides global longitude/latitude coordinates.

Alternatively, the system of the present invention includes the method of providing an off-vehicle mapping database accessible by calling a 900 toll number to obtain data which can be used to plot the vehicle's current position and/or movements.

Brief Summary Paragraph Right (15):
Other applications include obtaining roadside assistance, so that when a driver is lost, he/she may call a central station to download from the GTS unit of the vehicle its present spacial coordinates and obtain in return information such as how to get to a desired destination. Of course, the system can be used for calling emergency services such as ambulance, tow truck, police, and similar services.

Drawing Description Paragraph Right (2):
FIG. 2 is a diagrammatic/circuit illustration of a circuit means for converting GPS space coordinates to speech.

Detailed Description Paragraph Right (1):
The present invention constitutes a GTS, i.e. a Global Tracking System, for enabling monitoring and tracking vehicles, or any other moving objects such as children or adults hiking in the woods, or product containers, etc. With reference to FIG. 1, the GTS 10 comprises a conventional global positing system (GPS) receiver 12, operating in conjunction with a similarly entirely conventional, cellular telephone 14 having auto answer and auto dial features. The GTS 10 further includes an interface 16 for coupling the GPS receiver 12 to the telephone 14 and further interface hardware, such as a dual tone multiple frequency (DTMF) board 18, for providing interfacing to the vehicle alarm 20 and/or ignition/lighting/door locks systems 22 of the vehicle.

Detailed Description Paragraph Right (2):
As is well known, the GPS receiver 12 comprises an antenna 26 for communicating with an array of satellites and thereby, through a triangulation technique, to output latitude and longitude coordinates defining the current global position of the GPS receiver 12. As known, the GPS receiver 12 also outputs speed and direction data. The digitally coded data from the GPS receiver 12 is supplied to the interface 16 which includes speech filtering and synthesizer circuitry to convert the digital data to voice information and to wirelessly transmit that voice information via the antenna 36 of the cellular telephone 14 to a telephone of the vehicle owner 28. Alternatively (or additionally), the information may be called to a police telephone 30, to a privately operated central control station 32 and/or to the vehicle owner's home computer 34, etc.

Detailed Description Paragraph Right (3):
FIG. 2 further details the overall system configuration, and shows that the GPS receiver 12, which can be any known receiver unit made by Motorola, Encore, Rockwell, etc., has a digital serial output provided through a connector 40. The serial output is supplied to the input of a filtering interface circuit 42, for example a MAX-232 standard filtering interface and voltage-level adjusting circuit, to further supply the filtered longitude/latitude coordinate data via a further connector 44 to a speech synthesizer circuit such as, for example, an RC system 8600 speech board 45. The board 44 serves to convert the spacial coordinates into spoken words, which are then played through a speaker 46 to the microphone input of the cellular phone 14. Voice reproduction can also be made by recording on a digital IC chip #SD-9 such words as North, East, South, West, numerals e.g., one, two, etc., and speed, e.g. miles per hour. The GPS output data will then go through a microprocessor controller to retrieve the numbers and words needed. Speech synthesizer circuits, as such, are well known in the art and one embodiment thereof is illustrated herein in the form presented in FIGS. 10a, 10b and 10c. See also the dialor controller schematic presented in FIGS. 11a and 11b.

Detailed Description Paragraph Right (4):
FIG. 3 is the generalized block diagram of a speech synthesizer. Overall control is provided by a controller 50, for example, a microprocessor, which interfaces with data and status registers 52 and 54, through which parallel digital data is supplied and/or received. Communication with the controller 50 is also provided via the serial port 56. In any case, digital information, for example from the GPS receiver 12, can then be used to access wave tables and other speech generating means stored in a ROM 60 to be supplied to a random access memory (RAM) 58 and used to provide inputs to the

digital to analog converter (DAC) 62, which in well known manner, converts the digital data to an analog speech signal 63. The speech signal 63 is then passed through a low pass filter 64 and then to a power amplifier 66 to drive a speaker, for example, the speaker 46 in FIG. 2. The sound volume is adjustable via a potentiometer 68.

Detailed Description Paragraph Right (11):
To prevent repeated, unauthorized attempts to access the GTS unit 10, the program checks in block 132 whether the number of failed attempts to access the system has exceeded a predetermined count. If yes, the program proceeds via block 122 to the start position. Otherwise, the program returns to its initial point to continue monitoring of incoming calls and/or keyboard entries.

Detailed Description Paragraph Right (14):
While the main program is being executed, the system receives periodic interrupts from an interrupt generator 206, as indicated in FIG. 8. Upon an interrupt, the program proceeds from block 200 to perform periodic housekeeping functions, for example, updating a map display in the vehicle pursuant to instructions located in block 202 (if the vehicle is equipped with that option). Other functions that can be performed periodically include checking the alarm and reporting triggering of the alarm at block 204.

Detailed Description Paragraph Right (15):
The GTS system of the present invention may include, in addition to the on-board GTS unit 10, off-vehicle components as described below by reference to FIG. 9. Thus, the system may include a home computer with a modem for communicating with the GTS unit via a telephone connection. The home computer has special software including an initializing block 220, and program code designed to periodically call the vehicle, as indicated at 222 and note the vehicle location (block 224). If the software has been so programmed, at block 225 the software determines whether the vehicle has been moved. If it has been so moved while it was parked, this fact is noted and a report is generated at block 227. This report may include sounding an alarm at the site of the computer, or calling the owner at a predesignated telephone number to report that the vehicle has just been stolen and to provide the current location thereof. Thus, by the software being programmed to call the vehicle every half hour or so, practically immediate reporting of a stolen vehicle is made possible. An owner alert is also generated when the system is unable to call the vehicle, presumably because the GTS unit has been damaged by a thief.

Detailed Description Paragraph Right (16):
The home computer software may include many other options. Thus, at block 229 the software determines whether a address command has been entered. If it has, the address is found in a look up table based on the latitude/longitude coordinates that were obtained from the vehicle. The information can be stored or displayed on the panel. If requested, the owner can monitor (block 233) the sound inside the vehicle while it is being legitimately used by others, for example young adults, employees, etc. Block 235 responds to requests to create a map display at the home computer of a route being driven by the vehicle. Block 237 responds to commands requesting that data be relayed from the vehicle to the home computer be stored or played to the owner. This information can include telephone messages stored in the GTS unit 10 on-board the vehicle.

Detailed Description Paragraph Right (17):
As already mentioned, blocks 160-174 of FIG. 7 represent the various functions performed by the GTS unit 10 of the present invention. Thus, the software block 160 represents the software block which responds to the owner's telephonic request for a voice message announcing the coordinates of the vehicle. For example, the audible message might be "30.degree. latitude north, 25.degree. longitude east", etc. A different command, represented by block 162 controls turning on the vehicle lights, or perhaps flashing them to alert tracking personnel. In the same vein, the block 164 issues the command that allows the owner to remotely disable the vehicle ignition, when and if the vehicle has either stopped or it is otherwise safe to do so based on inputs from the GPS receiver 12 which also provides speed and direction information. Communications with the cellular telephone 14 may be executed (block 166) in a silent mode, so that the person driving car is not even aware that the vehicle telephone has responded to a call.

Detailed Description Paragraph Right (18):
If the GTS owner has mapping software such as Delorme, Map Expert, or any type of software that will give the location on a map when latitude and longitude information are inputted, the system, as indicated in block 168, plots the path of the vehicle on a map. If the vehicle owner does not have this software option, then the vehicle owner can call a central station, provide the latitude and longitude information and the central station will supply the current location of the vehicle. This can be accomplished by, for example, calling a 900 telephone toll number, thus providing a profitable central station.

Detailed Description Paragraph Right (19):
Block 170 is dedicated to a portion of the program which monitors whether the alarm of the vehicle has been triggered. It can also be programmed to monitor movements of the car. Thus, if the car has been parked and the vehicle alarm has somehow been defeated, a change in position of, for example, 500 feet will cause an internal, silent alarm to be generated. In response,, the software will cause the telephone to silently call the vehicle owner at any of several telephone numbers. Thus, the invention provides 24 hour satellite monitoring (if desired) of the vehicle by detecting movement in any direction for more than a given distance, e.g., 500 feet, 1,000 feet, etc. The vehicle movement monitoring is accomplished with the GPS receiver, which has an output indicative of such position change, or with the software in the interface. Since many owners do not maintain vital information, the system itself can be programmed to automatically broadcast to the police the vehicle's license number, vehicle identification number, the cellular number, access code and the like in the block 170. The software block 171 is dedicated toward providing mapping functions within the vehicle. Thus, the driver may actuate a sequence of keys to cause the GTS software to call a home computer, provide with coordinates, from time to time, and create a map of a route travelled, or a route to be travelled either on a florescent or LCD display, or print such map on a miniature printer (not shown) in the vehicle.

Detailed Description Paragraph Right (21):
In terms of hardware, the present invention can use a GPS receiver 12 and take advantage of the ASK II or NEMA 0183 data output thereof and couple this data to an ASK II voice converter board. This converter board will convert the ASK II or text to speech (latitude and longitude, speed and direction) by using conventional or special speech synthesizer boards.

Detailed Description Paragraph Right (31):
Further aspects of the invention include the ability to locate, i.e., house, the GPS receiver unit 12 inside of a MOTOROLA Flip-Phone battery compartment (FIG. 15). Another approach is for the person owning a Flip-Phone to slide the GPS receiver 12 (FIG. 12) onto the existing Flip-Phone (FIG. 13). As noted previously, by connecting the GTS unit 10 to the microphone and speaker of any cellular phone (FIG. 14), and by activating the emergency dialer or a pre-programmed phone number stored in the memory of the cellular phone, the invention enables the cellular phone to automatically dial an emergency phone number to alert the owner of a break-in or movement of his/her vehicle. This can be effectuated, for example, by activating the number 1 key for 11/2 seconds on a MOTOROLA Flip-Phone. Responsive to the alarm, the owner then inputs his access code number to download the spatial coordinates from the GPS receiver 12 to help find the vehicle. By using the built-in movement alarm contained in the GPS receiver 12, the system of the present invention is portable and self-contained and, as such, need not necessarily be physically attached or be hard-wired to another object or device such as the interface 16 or DTMF circuit 18.

Detailed Description Paragraph Right (33):
In the above description, communications with the GTS unit is via telephone transmissions of voice or data. Instead, the data can be converted to DTMF tones and these tones can be sent via the cellular phone or any other means of communication to a remote location where it is to be decoded by an inexpensive DTMF decoder (eliminating the need for a modem). Such data can be transmitted by UHF, VHF or any transmitter available. Finally, the GTS unit can be made into a watch size using an existing cellular phone like MICRO-TALK WATCH and piggybacking a GPS receiver and voice module onto it.

Detailed Description Paragraph Right (38):
The above is accomplished by programming the GPS and the micro controller to signal when the GPS detects changing of coordinates of more than a specified programmable threshold and by triggering and activating a preprogrammed emergency phone numbers in the cellular phone memory. Instead of using a cellular transmitter as described above, a transmitting device interfacing with the GTS may interface with a house phone. The transmitter should have enough wattage to provide sufficient signal strength to broadcast over the preprogrammed distance threshold selected for triggering the GTS. The non-cellular house phone would do the dialing of the emergency phone numbers.

Detailed Description Paragraph Type 0 (1):
1. A navigation feature, enabling a person who owns the GTS unit and a laptop PC to contact their laptop PC directly through the GTS unit.

Detailed Description Paragraph Type 0 (2):
2. Mapping software may then be located in the laptop PC (block 171) and the location of the vehicle plotted on the PC monitor as the vehicle is moving. This option includes the possibility of setting a destination address, to obtain mapped directions to the destination.

Detailed Description Paragraph Type 0 (4):
4. In accordance with yet another option, the GTS also provides UTM coordinates, if the vehicle owner does not want to call a 900 toll number or the owner does not have a PC. This provides a mapping option that allows the owner to rely on an inexpensive paper map that has pre-plotted UTM coordinates thereon.

Detailed Description Paragraph Type 0 (6):
6. If the vehicle owner is lost, he or she can call a central station and download data from the GTS to a central station. The central station can then provide information regarding the current location of the vehicle and directions to the destination. Naturally, the system inherently provides the ability to dispatch emergency crews such as ambulances, tow trucks, police, etc.

CLAIMS:

1. A global tracking system (GTS) for monitoring an alarm condition associated with and locating a movable object, the GTS comprising:

a cellular telephone located with the movable object;

a GPS (global positioning system) receiver located with the movable object, the GPS receiver being effective for providing data reflecting a present spacial position of the movable object, in terms of spacial latitude/longitude coordinates;

an interface between the GPS receiver and the cellular telephone, the interface being connected between the GPS receiver and the cellular telephone and including circuitry for transmitting the spacial coordinates from the GPS receiver through the telephone, wirelessly to a remote location; and

an alarm for detecting that the object has been moved, by calculating a spatial movement of the object which exceeds a predetermined distance based on information supplied by the GPS receiver, and the alarm initiating the transmission to the remote location the spatial coordinates from the GPS receiver when said movement of predetermined distance has been detected.

11. The tracking system of claim 5, including means for generating a map of a route travelled by the vehicle.

16. A global tracking method for monitoring an alarm condition and locating a movable object, the method comprising:

outfitting the movable object with a cellular telephone;

outfitting the object with a GPS (global positioning system) receiver for providing data reflecting a present spatial position of the movable object, in terms of spatial

latitude/longitude coordinates thereof;

interfacing the GPS receiver and the cellular telephone via an interface and using the interface to convert the spatial latitude/longitude coordinates to speech and transmitting the speech through the cellular telephone to a remote location; and

detecting an alarm condition by calculating movements of the movable object which exceed a predetermined distance based on the data provided from the GPS receiver and transmitting an alarm to the remote location responsive thereto, when said movements of predetermined distance have been detected.

17. A global tracking system (GTS) for monitoring an alarm condition and locating a movable object, the GTS comprising:

a GPS (global positioning system) receiver located with the movable object, the GPS receiver being effective for providing data reflecting a present spatial position of the movable object, in terms of spatial latitude/longitude coordinates;

means for noting an alarm condition by detecting movement of the movable object which exceeds a predetermined distance; and

means for transmitting the occurrence of such movement wirelessly to a remote location in response to said alarm condition and when said movements of predetermined distance have been detected.

20. The tracking system of claim 17, in which the means for transmitting constitutes a cellular telephone and in which the GPS receiver is directly connected to a microphone and speaker which are associated with the cellular telephone.

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L11: Entry 21 of 85 File: USPT Nov 20, 2001

DOCUMENT-IDENTIFIER: US 6321158 B1
TITLE: Integrated routing/mapping information

Abstract Paragraph Left (1):
An Integrated Routing/Mapping Information System (IRMIS) links desktop personal computer cartographic applications to one or more handheld organizer, personal digital assistant (PDA) or "palmtop" devices. Such devices may be optionally equipped with, or connected to, portable Global Positioning System (GPS) or equivalent position sensing device. Desktop application facilitates user selection of areas, starts, stops, destinations, maps and/or point and/or route information. It optionally includes supplemental online information, preferably for transfer to the PDA or equivalent device. Users' options include route information, area, and route maps. Maps and related route information are configured with differential detail and levels of magnitude. Used in the field, in conjunction with GPS receiver, the PDA device is configured to display directions, text and map formats, the user's current position, heading, speed, elevation, and so forth. Audible signals identifying the next turn along the user's planned route are also provided. The user can pan across maps and zoom between two or more map scales, levels of detail, or magnitudes. The IRMIS also provides for "automatic zooming," e.g., to show greater detail or closer detail as the user approaches a destination, or to larger scale and lower resolution to show the user's overall planned route between points of interest. The IRMIS also enables the user to mark or record specific locations and/or log actual travel routes, using GPS position information. These annotated location marks and/or "breadcrumb" or GPS log data can be saved, uploaded, displayed, or otherwise processed on the user's desktop geographic information or cartographic system. The IRMIS application and data may be distributed online and/or in tangible media in limited and advanced manipulation formats.

Parent Case Paragraph Right (1):
This patent application is a continuation-in-part (CIP) of the David M. DeLorme et al U.S. patent application Ser. No. 08/661,600 filed Jun. 11, 1996, for COMPUTER AIDED ROUTING AND POSITIONING SYSTEM, now U.S. Pat. No. 5,802,492, issued Sep. 1, 1998, which is a CIP of U.S. patent application Ser. No. 08/381,214 filed Jan. 31, 1995 for COMPUTER AIDED ROUTING SYSTEM, now U.S. Pat. No. 5,559,707, issued Sep. 24, 1996, which is a CIP of the David M. DeLorme et al U.S. patent application Ser. No. 08/265,327 filed Jun. 24, 1994 for COMPUTER AIDED MAP LOCATION SYSTEM, now abandoned, and the contents of these related patent applications are incorporated herein by reference.

Brief Summary Paragraph Right (1):
This invention relates to a new Integrated Routing/Mapping Information System (IRMIS) for travel planning, travel guidance, and recording travel locations and paths during business or recreational use, particularly in regard to the linkage of small, memory-limited computing systems with personal and/or mainframe computers. The invention may include the capability to provide an interactive computer travel-planning guide for determining a route between a user selected travel origin and travel destination following user selected intermediate waypoints along the way. System software determines the preferred travel route within user selected constraints. The user can also select among a plurality of types of geographically locatable points of interest (POIs) within a user-defined region of interest along the travel route. A database enables the incorporation of travel information such as graphics, photos, videos, animations, audio and text information about the user

selectable POIs along the way as well as about transportation routes and waypoints. From the user selected and user-defined transportation routes, waypoints, and POIs along the travel route, the software constructs a user customized multimedia travelog for preview on a computer display of the user-defined travel route. Based on the user-customized previews, the travel route including transportation routes, waypoints, and points of interest can be updated or changed according to the user preferences and choices. Modified travel routes can be previewed with further multimedia travelogs until a satisfactory travel route is achieved. The user can output a travel plan, i.e.; downloading waypoints electronically and/or printing out maps with route indications and text travel directions.

Brief Summary Paragraph Right (2):
The IRMIS is applicable for use with the Global Positioning System (GPS), radio location systems, dead reckoning location systems, and hybrid location systems. For example, the GPS satellite system is used with a GPS receiver for displaying waypoint data and limited routing data of the IRMIS user on the computer display for correlation of location with surface features or mappable features. Data generated by the GPS receiver may be used for "real time position updates" in the IRMIS computer display or may be recorded by the GPS receiver in the field for subsequent downloading to IRMIS software and IRMIS computer display. As well, IRMIS-generated data may be used within the GPS receiver by an IRMIS user for guidance in the field apart from a desktop IRMIS platform. The user can follow the IRMIS generated route using just a GPS device alone, or with the further aid of other IRMIS output such as printed maps. The user can accomplish this visually and intuitively between human readable forms of a map without the necessity of a users physical determination of latitude and longitude and without requiring any mathematical calculations. Text and voice or audio outputs can be provided to facilitate use and reading of the printed maps and/or GPS devices. The invention also adds a communications dimension to the maps for adding and updating the latest spatially related data, for providing software tools for map analysis and reading, and generally for communications between computer systems and devices and between users in a variety of combinations.

Brief Summary Paragraph Right (3):
The present invention is particularly applicable to small computers identified as personal digital assistants, palm computers, and any other sort of hand-held computer, defined generally herein as PDA computers. In particular, a PDA may be linked to a GPS receiver in a PDA/GPS format to log information associated with a travel route for subsequent processing through a standard personal computer or other relatively larger computer. It is to be noted that PDA travel logs and routing may include the association with a digital map display thereon with a paper map. However, given the ease of handling associated with a PDA, it is understandable that the PDA may act as a substitute for the paper map. Additionally, the PDA-related IRMIS, as implied above, involves the communication between a PDA and a desktop computer that has the storage and processing capability to provide a large array of digital maps with user-defined travel routes. Such communication is generally through hardwiring; however, it may be wireless as well.

Brief Summary Paragraph Right (6):
Similarly the American Automobile Association in cooperation with Compton's NewMedia also provides travel planning from starting point to destination point with stopping points in between. The CDROM product contains a database of travel information. However the multimedia information available from the database appears limited to "suggested routes of travel" again limiting user choice.

Brief Summary Paragraph Right (8):
Relatedly, there are a variety of mapping and positioning systems. One such system is a hand-held personal GPS navigation tool that has been developed by the Garmin Corporation of Lenexa, Kans. under the tradename Garmin GPS 45. The Garmin navigation tool incorporates a GPS receiver and a limited character display screen for displaying position information in alphanumeric and graphic characters. Another such system is a hand-held personal GPS navigation tool that has been developed by Trimble Navigation of Austin, Tex., under the trademark Scout GPS (TM). The Trimble navigation tool incorporates a GPS receiver and a four-line character display for displaying position information in alphanumeric characters. This hand-held GPS system can apparently display alphanumeric position information in a latitude/longitude coordinate system or

a Universal Transverse Mercator (UTM) coordinate system. The Trimble navigation tool can apparently also display proprietary coordinate system information for locating the position of a user on a standard topographic map. The Trimble GPS navigation tool displays in alphanumeric characters the horizontal and vertical coordinate distances of the user from the southeast corner or southeast reference point of any standard topographic map.

Brief Summary Paragraph Right (9):
A disadvantage of the Trimble GPS navigation tool is that it provides a display of coordinate system data only in alphanumeric characters on a multiline LCD display. The user must then perform mathematical measurements and operations to determine the user location on a particular topographic map. While the incorporation of GPS technology provides an improvement over dead reckoning and position estimation from topography, it necessarily requires user reference to quantitative measurements and calculations. Furthermore, the Trimble navigation device does not provide communications access to other geographical information databases for updated information on geographical objects in the spatial area of interest or communications access to other software tools for map analysis and reading. More generally, the Trimble navigation device does not provide a communications dimension for the map reading system.

Brief Summary Paragraph Right (10):
Silva Sweden AB and Rockwell International USA have developed a hand-held GPS compass navigator for use on any standard map. The GPS compass navigator incorporates a GPS receiver for locating the user on any standard map. A built-in "compass" gives range and bearing from the known user position to a specified destination. This information is updated on the GPS compass navigator as the user progresses toward the destination. The GPS navigator is described as being in the form of a guiding "puck" that apparently rides or is moved over the standard map at the user location. It cannot display multiple geographical objects at the same time and cannot communicate with other sources of spatially related map information.

Brief Summary Paragraph Right (11):
In the increasingly important field of PDAs and handheld organizers, mapping technology that resolves the desire for well-defined maps and user-selectable maps with the memory limitations associated with PDAs is becoming increasingly important. The desktop computers provide the user with the capability to select geographic areas, travel origins and destinations, points of interest along the travel route, levels of map detail for maps covering wider geographical areas, and linkage to even greater computing capability by way of on-line access. The desktop mapping available today also provides for GPS linkage for travel marking as well as the means to provide audio and textual directional information. PDA cannot to date provide such capacity. Prior attempts at enabling PDA usage in regard to selectable travel routes has been limited to single-route textual itineraries. It is therefore desirable to provide in a PDA user-selectable mapping information similar to that provided through desktop computers.

Brief Summary Paragraph Right (12):
It is an object of the present invention to provide a new integrated routing/mapping information system (IRMIS) capable of enabling the mating and cooperation between desktop and handheld devices, including the automatic updating of related databases whenever the desktop PC and handheld PDA link together. The PDA or handheld personal organizer may be optionally linked to a GPS receiver. It is also an object of the present invention to provide the means to take advantage of the strengths of the desktop or home-base application which provides wider geographical coverage and a fully implemented map/route/point-of-interest (poi) cartographic system, which desktop enables user selectivity or customization of map and route information--optionally tapping into online information. It is another object of the present invention to create data-cutting alternatives such that certain user selections of geographic area, start, finish, POIs, levels of detail or map magnitudes may be effectively downloaded to the PDA/GPS that produce compact map and/or route information "packages" comprising black-white bitmaps, text directions lists, point information organized in differential magnitude configurations which e.g. provide more detail and particular kinds of information around waypoints, less detail and perhaps more major road driving information along the routes between waypoints. It is a further object of the present invention to provide a means to enable a PDA to display text directions and maps

(without GPS), serving similar functions to map/itinerary travel plan printouts and to facilitate in a PDA/GPS combination a map display of user's current position, and/or prompting and beeped warnings relative to text directions, as well as heading, distance, speed and other real time GPS data. The present invention is further designed to facilitate in a PDA/GPS configuration location marking and breadcrumb or GPS log functions which can be displayed on the PDA and/or uploaded, displayed, and otherwise processed back at the home-base desktop. Yet a further object of the present invention is the development of a PDA/GPS application can include programming whereby the GPS output controls map/point/route information content and levels of detail--as illustrated by "automatic zoom" upon arrival at area mapped at lesser/greater level of detail or, when a GPS receiving system "senses" that the vehicle has slowed down or stopped, map and point information displays automatically refocus or "look about" to see about restaurants, lodgings or other area attractions.

Brief Summary Paragraph Right (14):
A further object of the invention is to provide an IRMIS for use with radio location systems, dead reckoning location systems, and hybrid location systems for displaying user location. For example, the GPS satellite system can be used for displaying the location, direction of travel, route, speed, and other travel data of an IRMIS user on a generalized grid quadrangle for correlation of user location on a coinciding printed map. Such is accomplished by direct sensory, visual, and intuitive methods. As well, the GPS satellite system may be used in the field for recording waypoint data and limited routing data of an IRMIS user for later data transfer and IRMIS computer display. Additionally, the GPS satellite system may be used in the field for updating waypoint data and limited routing data of an IRMIS user for immediate data transfer via wireless data communications from a remote field location to an IRMIS desktop platform.

Brief Summary Paragraph Right (15):
The present invention is an improvement over the prior art of simple PDA operations in that the IRMIS technology enables advanced map displays, rather than simple textual information. It permits current-position displays when linked with GPS. Moreover, the developed PDA system of the present invention can act as a personal organizer as well as a "hotsynch" link between truly portable devices and desktop devices.

Brief Summary Paragraph Right (17):
Another advantage is that IRMIS users in the field may simultaneously navigate a travel route generated by IRMIS software while recording or tracking locations or sequences of locations. Such locations may be designated by the user as new POIs and sequences of locations may be transferred from the GPS receiver to the IRMIS desktop platform as an ordered waypoint list that designates a new travel route. Further, fast and accurate surveying is enabled from GPS receiver location recording data made by the user in the field when transferred to the IRMIS desktop platform for computerized data mapping by the IRMIS software.

Brief Summary Paragraph Right (18):
In order to accomplish these results the present invention provides IRMIS for use with a PDA with display, a digital desktop computer with display, and a detachable handheld GPS receiver device which provides waypoint list management tools and compass bearing, distance, speed of travel, estimated time until arrival, and other information in relation to the next waypoint on an overall route. A variety of other peripheral equipment is also provided as hereafter described. The PDA is preferably a 3COM PALM.TM. or handheld computer with WIN CE.TM. operating system. A set of electronic maps is provided for presentation on the desktop computer display. The electronic maps depict transportation routes having route intersections and identified waypoints at geographical locations along the transportation routes. The route intersections and identified waypoints depicted on the electronic maps are identified in the desktop computer by coordinate locations of a selected geographical coordinate system.

Brief Summary Paragraph Right (19):
An IRMIS database contains geographically locatable objects (loc/objects) also referred to as points of interest (POIs) identified by coordinate locations in the geographical coordinate system. The POIs are organized into a plurality of types for user selection of loc/objects or POIs individually and by type. The loc/object or POI types constitute electronic overlays of the database for display over the electronic

maps on the computer display. As used in this specification and claims, the phrase points of interest or POIs is generally used to refer to loc/objects for which multimedia information is available for describing the POIs and presenting the points of interest in a multimedia travelog as hereafter described. It is to be noted that in the context of PDA linkage, multimedia displays are optional rather than the focus of the present IRMIS invention.

Brief Summary Paragraph Right (21):
IRMIS software is constructed for user travel planning using the electronic maps presented on the desktop computer display. The IRMIS software permits user selection of a travel origin, travel destination, and desired waypoints between the travel origin and travel destination. The IRMIS software calculates, delineates and displays a travel route between the travel origin and the travel destination via the selected waypoints. The travel route is calculated according to user choice of the shortest travel route, quickest travel route, or user determined preferred travel route. As used in the specification and claims, waypoints refers to the origin and destination of a possible route and intermediate points or places along the way including major road and highway intersections, joints or turning points at connected short line segments of major roads and highways, place names situated on major roads and highways, and as hereafter described, POIs near the major roads and highways.

Brief Summary Paragraph Right (22):
The IRMIS software permits user selection of a particular map, area, or a point of interest. The IRMIS software further enables routing and the extraction or cutting of a route as well as area maps for downloading to the PDA. The IRMIS route map that is developed is essentially a larger scale map encompassing a start and a finish of the route. Included is at least one map of more detailed, greater resolution and/or higher magnitude maps of the start, the finish, and, possibly, other waypoints or POIs. That is, the present invention permits the user to select an area or route on the desktop computer-displayed maps and create PDA maps that are cut in accordance with that selection. This is an advantage over the prior art which was limited to pre-cut, one-size-fits-all maps for specific regions, areas, or cities.

Brief Summary Paragraph Right (23):
The electronic maps, IRMIS database, and IRMIS software are typically stored on a CDROM and the digital computer incorporates a CDROM drive. The IRMIS software may include a replace function for updating the electronic maps and IRMIS database on the CDROM with replacement or supplemental information from another memory device. Additionally, the IRMIS database may be accessed via the Internet and other online sources.

Drawing Description Paragraph Right (1):
FIG. 1A presents a diagrammatic perspective view of home-based desktop IRMIS of the present invention linked to a PDA for downloading/uploading route, map, point-of-interest, and other information.

Drawing Description Paragraph Right (2):
FIG. 1A1 is a schematic representation of the IRMIS of the present invention in context using a PDA with cradle in combination with a GPS receiver and a computer device.

Drawing Description Paragraph Right (3):
FIG. 1A2 is a schematic representation of the IRMIS of the present invention showing a PDA used in conjunction with a paper map.

Drawing Description Paragraph Right (4):
FIG. 1A3 is a schematic representation of the IRMIS of the present invention showing a GPS receiver device in relation to the database, a GPS, and peripheral wired and wireless communication systems.

Drawing Description Paragraph Right (6):
FIGS. 1A6(1)-1A5(16) illustrate PDA output and interface displays and screens in regard to use of the IRMIS of the present invention.

Drawing Description Paragraph Right (7):

FIGS. 1B-1M, 1O and 1P illustrate example desktop screen displays and user interfaces for IRMIS while FIG. 1N illustrates an example hard copy printout of a travel plan prepared by IRMIS, or alternatively, digital IRMIS travel plan output.

Drawing Description Paragraph Right (9):
FIG. 2A depicts IRMIS protocols for the automated cutting or extraction of one or more sets of point, route, map, textual, and/or multimedia information, based on user desktop selections, for downloading into PDA/GPS.

Drawing Description Paragraph Right (10):
FIG. 2B illustrates uploading of location marks, GPS logs and other information from PDA/GPS into IRMIS desktop home base.

Drawing Description Paragraph Right (13):
FIG. 5 is an example of a map display presented to the user on a monitor display by IRMIS.

Drawing Description Paragraph Right (14):
FIGS. 5A, 5B and 5C are simplified screen displays showing alternative strategies and methodologies for circumscribing points of interest within respective defined areas of a selected travel route.

Drawing Description Paragraph Right (19):
FIG. 9 illustrates GPS controls for PDA display variables.

Detailed Description Paragraph Right (2):
Included for use with IRMIS 100, the desktop computer 105 is integrated with a handheld or palmtop personal organizer PC, also known as a personal digital assistant or PDA, as shown at 102, in a cradle facilitating connection 106 with the desktop. This PDA, at 102, is detachable for portable use, typically in conjunction with a GPS or equivalent position information device as described hereafter. The "home-base" desktop personal computer system 105 and the detachable PDA communicate at 106 in FIG. 1A via plug-in wiring. The desktop/PDA interface 106 can be any means which facilitates data transfer including wireless infra-red, diverse kinds of wireless and other modems, and data transfer by various intermediate memory storage devices e.g. diskettes, PCMCIA cards and so forth. This communication interface between the portable PDA and home-base desktop facilitate transfer of a wide range of geographic data--including map, route, or point information--and other information. For example, maps of an area of interest to the user can be selected on the desktop and downloaded to the PDA for portable use. Information recorded on the detached PDA 102 at remote locations, including annotated location marks and recorded "breadcrumbs" or points along an actual path of travel for example, can be brought back to and then transferred into the desktop 105 via the data transfer interface 106.

Detailed Description Paragraph Right (3):
Alternative embodiments could include other input devices e.g. voice recognition system, joystick, touch-screen, scanner for printed map input, simplified keypad, etc., not represented here. FIG. 1A discloses IRMIS 100 implemented on a single, stand-alone, desktop style, personal computer. The software technology, which facilitates interactivity between routing and multimedia, also works on a more portable laptop or notebook computer, a handheld personal digital assistant (PDA), embedded in a travel planning appliance or an in-vehicle navigation system, as well as on mainframes of various kinds, distributed work stations, or networked systems. Alternatively, users can also operate IRMIS 100 from a remote interface through wireless or hard-wire links connecting with a distant computer system or a central service bureau as shown at 109.

Detailed Description Paragraph Right (4):
FIG. 1A shows a map book or set of printed maps typically on paper media 128 corresponding to the electronic or digital map 122 displayed on the screen or monitor 117. The printed maps 128 can be consulted as an aid in using the corresponding electronic or digital maps 122 displayed on screen, and the hardcopy travel plan printouts 126 derived from interactivity between the routing and multimedia elements of the invention. It is expected that users will printout such hardcopy travel plans 126 to guide and direct their journeys on foot, in vehicles, or by other means of

travel. Alternatively, the IRMIS invention provides portable PDA/GPS capability to guide users and record information at remote locations as described hereafter.

Detailed Description Paragraph Right (5):
The hardcopy travel plan 126 illustrated in FIG. 1A consists of a strip map noting points of interest, travel directions and critical turning points along the recommended route, described in more detail hereafter. Such hardcopy travel plans, typically printed on paper, comprise a portable and compact form of output from the system, useful and easily read in field situations, without the expense or burden of carrying even a small computer device. A variety of other forms of digital and printed media output can result from the combination of the software routing and multimedia processes, as described hereafter.

Detailed Description Paragraph Right (6):
The user 103, in FIG. 1A, is operating both the routing and related multimedia elements of the invention. The monitor 117 screen is filled with an electronic analog map (or digital map) display 122 on which departure points, destinations and other waypoints can be entered or deleted and the shortest, fastest or otherwise optimized routes calculated, as described in more detail below. At the same time, in a multimedia window 120 superimposed upon the map display, the user 103 is engaged in viewing, hearing, or responding to a selectable, multimedia presentation related to points of interest and locations displayed on the underlying map screen 122.

Detailed Description Paragraph Right (7):
For purposes of this specification the term multimedia embraces all manner of graphics, text, alphanumeric data, video, moving or animated images, as well as still images, photographs and other audio or visual information in digital or analog formats. Multimedia also includes audio output options, voice, music, natural and artificial sound, conveyed to users through a speaker system 107 or earphones 108. As detailed hereafter, the invention stores, manages and retrieves a database of multimedia information in relation to specific places on or near the surface of the earth, referred to herein as points of interest (POIs), or geographical sites or locations. These are geographically locatable objects (loc/objects) for which multimedia information is available in the IRMIS database. Generally, POIs can be represented in both digital and print media cartography and are situated or described by standard geographic coordinates such as latitude and longitude, UTM, State Plane, or equivalent map location systems.

Detailed Description Paragraph Right (8):
From the digital map and routing function shown in FIG. 1A at 122, the user 103 can select one or more particular geographic locations, or points of interest (POIs), in order to view, hear or manipulate related information in the multimedia dimension of the invention. FIG. 1A shows the multimedia element of the invention as an episode in a multimedia presentation comprised of graphics or text, shown in an on screen window 120, or audio output conveyed to the user 103 via a speaker 107 or earphones 108. For example, in the multimedia window 120, the user 103 can view and selectively respond to color photographic or video images or related textual information about a specific location, or group of locations. Locations are chosen by the user working within the underlying digital map and routing dimension of invention, illustrated at 122.

Detailed Description Paragraph Right (9):
More specifically, FIG. 1A shows a scenario in which the user 103 has selected a particular lakeside location 124 on the underlying digital map, or in conjunction with a route or a waypoint along a route. The specific lakeside location 124 is shown as an "X" in a circle 124 on the simplified drawing of a typical digital map screen 122. The user 103 picked this point of interest located by a lake by means such as a mouse clicking operation at the location or placename as depicted on the digital map 122. The location can also be identified by words or symbols along a displayed route on the underlying digital map screen 122, by selection from a list of place names or from a list of types of locations, or by other routine or state of the art inputs.

Detailed Description Paragraph Right (10):
The user's choice of a particular location prompts a multimedia presentation 120 of information related to the selected place e.g. stills or video pictures of the lake, local events, places to stay or eat, attractions and recreational opportunities,

related text or audio narrative, local history, lore, even complex or extensive data on topographic, environmental, demographic, real estate or marketing information, etc. The multimedia presentation is illustrated by the graphic image of a view of the lake, sailboat and mountains on the far shore, in the window 120, accompanied by related audio output 107 or 108. IRMIS 100 enables a user to prompt a multimedia presentation 120 on a location 124, or group of locations, selected from within a digital or electronic mapping system 122, equipped to do routing functions and displays 123.

Detailed Description Paragraph Right (11):
FIG. 1A additionally illustrates procedures whereby users can modify waypoints and other route parameters from within the multimedia element of the software invention. Typically, routes or waypoints are displayed as highlighted line segments or points 123 on the digital or electronic map 122. Routes and waypoints may also take the form of map symbols and annotations, or of ordered lists of place names, travel directions, geographic coordinates or various other location identifiers, as described hereinafter. IRMIS 100 combines routing and multimedia elements by enabling the user 103, to add, delete or insert one or more particular geographic locations or points of interest. This is achieved based upon the presentation of multimedia information about those locations, as new or modified input for additional processing of the route.

Detailed Description Paragraph Right (12):
In FIG. 1A, the lakeside location 124 and the route 123 on the desktop digital map screen 122 could also include one or more points marked and/or actual travel routes recorded with the IRMIS portable PDA/GPS unit described hereafter. Thus, map, route, or point information recorded and/or recorded at remote locations on the PDA/GPS component of IRMIS can be displayed, incorporated and otherwise processed by the more fully articulated desktop GIS, or computerized geographic information system 105.

Detailed Description Paragraph Right (13):
For example, in FIG. 1A, mouse manipulatable buttons along the bottom of the multimedia window 120 enable the user 103 to command IRMIS 100 to include the lakeside location 124, based on the multimedia presentation 120, as new input for routing. IRMIS 100 facilitates entry or deletion of locations, reviewed in multimedia subject matter, as new starting places, destinations, intermediate waypoints, or points of interest along the way as part of the user-selected route. FIG. 1A represents how user interactions with multimedia about locations can be used to change the route.

Detailed Description Paragraph Right (14):
FIG. 1A further illustrates output from IRMIS 100, a hardcopy printout 126, typically a customized or individualized travel plan in the shape of a strip map annotated with travel directions and related information. Output from IRMIS 100 is produced by combined interaction between the routing functions and user responses to the multimedia information about particular geographic locations. Thus, for one example, the hardcopy travel plan 126 exhibits attached points of interest, typically in the form of annotations connected with graphic arrows or pointers to particular geographic locations which fall within a predetermined distance from a displayed route. The user attaches such points of interest to a digital map route display from a multimedia presentation on those locations. Alternative forms of digital, audio, text, graphical, hardcopy or multimedia output from IRMIS 100 are detailed later in this disclosure.

Detailed Description Paragraph Right (15):
Output from the invention can result from a single, simple interaction between routing and multimedia elements. FIG. 1A illustrates a scenario whereby the user-selected only one point of interest, a place by a lake 124, close to a route 123 highlighted upon an electronic or digital map display 122. Next the user prompted the presentation of multimedia information in a window 120 concerning the lakeside point of interest. Prompted by the multimedia presentation, the user then pushed the "Attach" button in the command bar across the window bottom, or otherwise prompted IRMIS to include the lakeside location as an annotated point of interest within a specified distance from the highlighted route displayed upon the map screen or printed on a hardcopy travel plan.

Detailed Description Paragraph Right (16):
In FIG. 1A,the hardcopy travel plan 126 output actually contains arrows or pointers from three annotation boxes to three corresponding points of interest attached to the

strip route map output. Moreover, the highlighted route running up the center of the strip map format may reflect waypoints added or deleted over the course of a sequence of interactions between the multimedia and routing elements of the invention. Users can utilize the invention to attach multiple points of interest, or make many modifications of actual waypoints and highlighted routes, working interactively between the multimedia database and the routing function. The system, as described hereafter, is flexible, selective and capable of series of multiple interactions and repeated iterations in order for the user to develop, alter and refine an individualized or customized travel plan through varied operational cycles, combining routing and utilization of the multimedia database on locations.

Detailed Description Paragraph Right (17):
FIG. 1A therefore illustrates but one episode in a potential series of interactions between the routing and multimedia sides of the system, for producing a customized travel plan output, as exemplified by the annotated hardcopy travel plan 126 and further detailed in FIG. 1N. In the alternative, such customized travel plan output(s) may be incorporated into one or more digital route, map, and/or point information "packages," i.e., specialized data sets prepared on the IRMIS desktop computer 105 for use in the portable IRMIS PDA 102, typically in conjunction with GPS, at remote locations--as detailed hereafter. Such a travel plan, and alternative forms of output can result from attaching multiple points of interest, waypoints, and route modifications based upon a succession of multimedia presentations of information on many locations to generate a custom travel plan tailored to the user's personal preferences, as expressed throughout the whole sequence of interactions.

Detailed Description Paragraph Right (19):
Generally, such PDAs, handhelds or "palmtops" are provided with user alphanumeric input means such as a miniature keyboard, the Palm Computing Platform "graffiti" language for handwritten stylus or pen-point input, and so forth. Hardware and software buttons provide for menus, paging, and other user selection and manipulation means. These portable devices are also typically equipped with gray-scale "touch-screens" for text/graphic display. Such "touch-screens" can be actuated at particular points and/or series of points by touching, tapping, or sliding on the screen with a stylus, or the equivalent of a pen or pencil point.

Detailed Description Paragraph Right (20):
The IRMIS invention--for example as embodied in Delorme's SOLUS.TM. software--provides a mapping or geographic information system application and data, for use on such PDAs, handhelds or palmtops and equivalent devices, as described hereafter. IRMIS or SOLUS map displays, as shown in FIG. 1A1, can be controlled, queried and manipulated by use of a stylus at 05, managing the virtual equivalent of typical computer mouse commands and manipulations. Alphanumeric text input, handwritten with stylus, is enabled at 06. For example, DeLorme's SOLUS is programmed so that, in a certain mode, the user can "mark" particular locations, recording exact geographic coordinates (e.g. lat/long), and make related notes or text annotations using the stylus or equivalent. By means well-known in the art of programming such portable devices, IRMIS in the form of the DeLorme SOLUS software also facilitates stylus on touch screen operations as follows: (1) the user "picking" points for additional information (e.g., a place name, lat/long, or other text or graphic information associated with the point); and (2) estimating distances by "sliding" the stylus between locations or points on the map display, or along a path or route or user-drawn pattern on the touch-screen map display--prompting an estimated distance readout in feet, kilometers or miles according the scale of the current map display.

Detailed Description Paragraph Right (21):
As embodied in DeLorme's SOLUS.TM. for example and implemented on state-of-the art PDAs or palmtops, the IRMIS invention further enables the user--by means of menus, toolbars, and the like--to select, alter and move between alternate screens, displays or output modes, as described in more detail hereafter particularly relative to FIGS. 1A4 and 1A5.

Detailed Description Paragraph Right (22):
FIG. 1A1 also shows connection of a portable IRMIS device to a GPS or Global Positioning System peripheral device. DeLorme Publishing Company, Inc., for example, provides GPSTRIPMATE.TM. and EARTHMATE.TM. GPS receiver accessories for personal

computers that provide data on current position, altitude based on radio signals from a set of satellites. The GPS receivers further provide very exact date/time information and compute information including the direction and rate of travel, time and distance to and from start or finish or intermediate waypoints along a planned travel route or course. Alternative position-sensing devices include loran, other radio location, dead-reckoning, and hybrid systems.

Detailed Description Paragraph Right (23):
As shown in FIG. 1A1, IRMIS facilitates use of the PDA to display map, route and point information with or without the GPS or equivalent real-time position detection. Illustrated in the foreground at 01 is a 3 COM Palm III.TM. in hand and capable of use as a digital improvement on conventional paper maps and maps, travel plans and itineraries printed out from computer mapping programs, even without GPS attached. As detailed hereafter, such PDAs or handheld devices provide added functionality when coupled with a GPS receiver, such as DeLorme's EARTHMATE or equivalent. FIG. 1A1, too, also illustrates a Phillips Velo.TM. "palmtop" at 07 with a small keyboard, connected to an EARTHMATE.TM. GPS receiver at 08, also implementing the SOLUS embodiment of the IRMIS invention. As detailed hereafter, the addition of GPS provides enhanced capabilities including exact location "marks", GPS logs or "breadcrumbs", real-time information on the current position, speed, elevation, time and distance to destination, as well as user-friendly automated adjustments of display variables on the PDA or handheld--including variables such as map scale, level of detail, additional information about points ahead along the expected direction or route of travel, and so forth. PDAs may also be equipped for communications, as show by the antenna at 09 in FIG. 1A1.

Detailed Description Paragraph Right (24):
FIGS. 1A2 and 1A3 are derived respectively from FIGS. 3 and 3A from the parent/grandparent U.S. patent application, Ser. No. 08/265,327 titled COMPUTER-AIDED MAP LOCATION SYSTEM (CAMLS) filed Jun. 24, 1994 by inventors David DeLorme and Keith Gray--assigned to DeLorme Publishing Co., Inc., which is also owner of the instant IRMIS application. IRMIS FIGS. 1A2 and 1A3 depict an alternative portable platform at 15 including built-in GPS, a display screen 18 for map information like vector data or routes at 35 and 36. Also displayed are point information at 38 and/or a moving arrow at 32 that indicate current position and travel direction of the user on the map display as detected by the GPS. As shown under the enlarged map screen view in FIG. 1A2, IRMIS portable PDAs or handheld devices can display information on the national edition, regional volume, page number and alphanumeric map grid indicators--e.g. "US-NE-41-C3" meaning United States map books, Northeast volume, page 41, grid C3. Such information aids the user 12 in locating and interpreting corresponding maps printed on paper in book form. The IRMIS invention can be used in conjunction with map books and/or printouts from map software; however, as described hereafter, IRMIS also provides intelligent digital alternatives to conventional kinds of map, route and/or point information pre-printed or printed-out on paper and other sheet media.

Detailed Description Paragraph Right (25):
FIG. 1A3 shows a generic feasible IRMIS portable platform with built-in GPS, wireless and hard-wire communication options, tangible supplemental applications and/or data in the form of one or more PCMCIA cards, and a CPU link for connecting to home-base desktop or other computers. Preferred IRMIS portable platforms, shown previously in FIG. 1A1, have a detachable GPS accessory, which is not needed when the PDA or handheld is "docked" in its "cradle" or connected to the home-base desktop for data transfer and/or synchronization. Such IRMIS PDAs can be used in the field without GPS, or used in conjunction with GPS receivers built into a vehicle or other appliance. The alternative IRMIS PDA, shown in FIG. 1A3 has the advantage (plus extra cost) of an integral GPS receiver--for example, avoiding the awkwardness in certain situations of two devices, the PDA and accessory GPS, connected with a cable.

Detailed Description Paragraph Right (27):
FIG. 1A4 illustrates typical IRMIS PDA screen displays--depicting user controls and IRMIS outputs. At a is "Directions" screen comprising a text list of directions and turning points. The "Directions" screen may be used with or without GPS. In the absence of GPS, this screen provides a substitute or complement for printed travel information such as paper maps or itineraries. With GPS, the "Directions" screen highlights the next turn, and provides graphic representation of the user's progress

along the bar at right. GPS also provides real time rather than estimated information on time and distance to next turn in the readouts at the bottom of the "Directions" screen.

Detailed Description Paragraph Right (29):
You can send your maps and Route Directions from Topo USA to a handheld computer to take with you as you travel. The same maps and directions that appear in Topo USA will be displayed on your handheld computer in DeLorme's Solus.TM. Pro.

Detailed Description Paragraph Right (30):
You can also combine DeLorme's GPS receiver with your handheld computer to monitor your position, heading, speed and elevation as you travel. You can follow your Route Directions as you travel and your handheld computer will beep 60 seconds before your next turn. And the maps ensure that you'll never get lost again.

Detailed Description Paragraph Right (31):
Safety Warning: Bring a passenger along to serve as GPS operator while you are driving a vehicle. Solus Pro should not be used in automatic navigation or guidance systems of for any purpose requiring precision measurement of distance or direction. See GPS Position Accuracy for additional information.

Detailed Description Paragraph Right (32):
Solus.TM. Pro is a separate application that allows you to integrate features of Topo USA with a handheld computer. You can send your maps and Route Directions from Topo USA to a handheld computer to take with you as you travel. The same maps and directions that appear in Topo USA will be displayed on your handheld computer.

Detailed Description Paragraph Right (33):
You can also combine DeLorme's GPS receiver with your handheld computer to monitor your position, heading, speed and elevation as you travel. You can follow the map or Route Directions as you travel and your handheld computer will beep 60 seconds before your next turn.

Detailed Description Paragraph Right (35):
You can send your maps and Route Directions from Topo USA to a 3Com.RTM., Palm Computing.RTM. or Windows.RTM. CE handheld computer to take with you as you travel. The same maps and directions that appear in Topo USA will be displayed on your handheld computer in DeLorme's Solus.TM. Pro application.

Detailed Description Paragraph Right (37):
Downloaded to a Palm Computing.RTM. organizer, you can take your Topo USA maps and Route Directions with you when you travel. Your entire route is spelled out in the palm of your hand with DeLorme's Solus.TM. Pro.

Detailed Description Paragraph Right (40):
When tracking with a GPS receiver, Solus Pro highlights the next leg in your Directions list and beeps 60 seconds before your next turn or route change. Use the arrows in the output boxes to select from a variety of options that you can display in the Directions mode while tracking (average speed, battery voltage, bearing, course, distance to Finish, etc.).

Detailed Description Paragraph Right (41):
Downloaded to a Palm Computing.RTM. organizer, you can take your Topo USA maps and Route Directions with you when you travel. Your entire route is spelled out in the palm of your hand with DeLorme's Solus.TM. Pro.

Detailed Description Paragraph Right (42):
There are two types of maps that you can send from Topo USA--map views and route maps.

Detailed Description Paragraph Right (43):
The map view is a black-and-white map of what was displayed in Topo USA on your desktop computer's screen. The rectangle on the map represents your map view and contains greater detail than the outlying map area. When centered within the rectangle, you can use the organizer's scroll buttons to zoom in and out for greater

or lesser detail. Tap the map to pan in different directions.

Detailed Description Paragraph Right (44):
The route map provides a bird's-eye overview of your route from your Start to your Finish. On the map, you'll notice two rectangles--one around the area of your Start and one around the area of your Finish. These rectangles provide street-level detail. When the map is centered within either of these rectangles, you can use the organizer's scroll buttons to zoom in and out for greater or lesser detail. You cannot zoom outside of the rectangles.

Detailed Description Paragraph Right (45):
When connected to a GPS receiver, your position appears as a gray crosshair on the map and updates as you travel. When your position is within either of the rectangles, use the organizer's scroll buttons to zoom in for greater detail. When your position reaches the edge of a rectangle, use the organizer's scroll buttons to zoom out. The black dot within the crosshair indicates the direction of your current heading.

Detailed Description Paragraph Right (47):
Choose Tools . . . Preferences . . . from the Solus Pro menu to access the Preferences mode. You can choose which mode to display when the program starts, whether or not you want Solus Pro to beep 60 seconds before your next turn and whether or not you want Solus Pro to log your trip as you travel. You can also reset the Tripometer and clear the Log file.

Detailed Description Paragraph Right (48):
Connected to DeLorme's GPS receiver, you can use your Palm Computing.RTM. organizer to monitor your position, heading, speed and elevation as you travel. Follow along on the map or with the Route Directions as you travel and Solus.RTM. Pro will beep 60 seconds before your next turn.

Detailed Description Paragraph Right (49):
Combining your Palm Computing.RTM. organizer with DeLorme's GPS receiver gives you dynamic maps and Route Directions that you can follow as you travel. As you progress from your Start to Finish, your position is indicated on the map and the next road you'll be traveling is highlighted in the Directions list. In addition, Solus.TM. Pro displays your next route change and indicates how far away it is in distance and time--your organizer will even beep 60 seconds before your next turn.

Detailed Description Paragraph Right (50):
While tracking in Solus.TM. Pro, you can log your travels and then HotSync.TM. them to Topo USA to play back on topographical maps.

Detailed Description Paragraph Right (51):
While tracking, SOLUS.TM. Pro lets you add Marks to indicate specific places along your route. These Marks can then be HotSynced to Topo USA to indicate their locations on topographical maps.

Detailed Description Paragraph Right (57):
Downloaded to a Windows.RTM. CE device, you can take your Topo USA maps and Route Directions with you when you travel. Your entire route is spelled out in the palm of your hand with DeLorme's Solus.TM. Pro.

Detailed Description Paragraph Right (58):
The map view is a black-and-white map of what was displayed in Topo USA on your desktop computer's screen. The rectangle on the map represents your map view and contains greater detail than the outlying map area. Press ALT+PAGE DOWN/PAGE UP respectively to zoom in and out for greater or lesser detail. Tap the map (or use the arrow keys) to pan/recenter to different areas.

Detailed Description Paragraph Right (59):
The route map provides a bird's-eye overview of your route from your Start to your Finish. On the map, you'll notice two rectangles--one around the area of your Start and one around the area of your Finish. These rectangles provide street-level detail. Press ALT+PAGE DOWN/PAGE UP to zoom in and out for greater or lesser detail.

Detailed Description Paragraph Right (60):
When connected to a GPS receiver, your current position appears as a white arrow on the map as you travel and your GPS status appears on the right of the command bar. When your position is within either of the rectangles, Solus Pro automatically zooms in for greater detail. When your position reaches the edge of a rectangle, Solus Pro zooms out.

Detailed Description Paragraph Right (61):
Press the X key to recenter the map on your current position. Press the K key on your keyboard to add a Mark at the map center. See Solus Pro Shortcuts for additional shortcuts and functions.

Detailed Description Paragraph Right (62):
Connected to DeLorme's GPS receiver, you can use your Windows.RTM. CE device (H/PC) to monitor your position, heading, speed and elevation as you travel. You can also follow along on a map or with the Route Directions as you travel and Solus.TM. Pro will beep 60 seconds before your next turn.

Detailed Description Paragraph Right (63):
Combining your Windows.RTM. CE device (H/PC) with DeLorme's GPS receiver gives you dynamic Directions that you can follow as you travel. The next road you'll be traveling is highlighted on the screen as you progress from your Start to Finish. In addition, Solus Pro displays your next route change and indicates how far away it is in distance and time--your H/PC will even beep 60 seconds before your next turn. Add a map and you're ensured of always knowing where you are and where you're going.

Detailed Description Paragraph Right (65):
Tap the Sky View button to open thee Satellite sky View dialog box to see the current positions of the satellites.

Detailed Description Paragraph Right (66):
Connected to DeLorme's GPS receiver, you can use your Windows.RTM. CE device (H/PC) to monitor your position, heading, speed and elevation as you travel.

Detailed Description Paragraph Right (67):
When tracking with a GPS receiver, you can monitor thee positions of the satellite.

Detailed Description Paragraph Right (68):
Once you begin tracking with your GPS receiver, Solus.TM. Pro automatically logs your route as you travel. When you stop tracking, Solus Pro prompts you for a filename and path in which to save this information. Log files have .gpl extensions and are saved to the DeLorme directory by default.

Detailed Description Paragraph Right (69):
Choose GPS . . . Disconnect to discontinue tracking and logging your route.

Detailed Description Paragraph Right (70):
As you are tracking, Solus.TM. Pro lets you indicate specific positions on you maps by using Marks.

Detailed Description Paragraph Right (71):
When in the Map mode you can access other dialog boxes by clicking the appropriate tools or through the following keyboard shortcuts.

Detailed Description Paragraph Right (72):
Pan the map in the corresponding direction (i.e., up, down, left and right)

Detailed Description Paragraph Right (73):
As described above, the user can re-configure screens on the PDA. For example, in FIG. 1A4(a), "Time to Next Turn" and "Distance to Next Turn" as shown, may be replaced with "Speed" and PDA "Battery Voltage." Other PDA screens may also be re-configured. FIG. 1A4(b) shows the "Navigate" screen, used with GPS, and showing text directions to the next turn above one configuration of time and distance read-outs. The "Position" screen shown in FIG. 1A4(c) gives the PDA/GPS user's current latitude and longitude--along with a selection of information such as speed and election derived

from the GPS; the user can "mark" or record the geographic coordinates of his/her current location at the bottom of the "Position" PDA screen. "Mode" and "Tools" shown in FIG. 1A4(d) enable to user to navigate, or page, among the PDA screens. The "Mark List" screen shown in FIG. 1A4(e) allows the user to page through and annotate "marks" which are records of particular location lat/longs. "Mark List" entries can relate to another device, such as a digital camera e.g. for purposes of recording and stamping the date, time and exact lat/long at which one or more digital photos are taken. As shown in FIG. 1A4(f), the "initialize" PDA screen facilitates setup of the gps--receiving, processing and recovery of GPS satellite signals.

Detailed Description Paragraph Right (74):
As shown in FIG. 1A5(a), the "Preferences" PDA screen facilitates user adjustments including start mode, route warning (e.g., audio "beep" one minute before next turn), and logging, or laying down "breadcrumbs" with the GPS (i.e., recording a series of positions, or geographic coordinates, at selected or pre-set time/distance intervals along a route or path actually traveled). Map screens of three different scales or magnitudes are shown in FIGS. 1A5(b)-1A5(d). The IRMIS invention is preferably implemented so that maps and related digital information, utilized in the PDA, comprises plural map scales or magnitudes and levels of detail. For example, as shown in FIG. 1A5(b) the PDA displays a map of a geographic area on the order of 50-100 miles square encompassing a planned route of travel. FIG. 1A5(d) displays a map scale of 1-3 miles square or a closer view of one route destination. Much greater detail of an exit, turn, waypoint, POI and/or destination is shown in FIG. 1A5(c) on the order of a map screen showing an area of 0.10 to 0.75 square miles. Further details of how IRMIS displays map, route and point information at multiple scales on PDAs, and how IRMIS maps are selected by the user, and automatically extracted or cut, at plural scales, around user selected points or routes, appears hereafter--with particular reference to FIGS. 5D, E, and F.

Detailed Description Paragraph Right (75):
The user can pan or move laterally within a map scale and/or magnitude on the PDA display, for example, by touching the screen that re-centers on the geographic point touched by the PDA user. The PDA user can also or additionally zoom or change map scales, or magnitudes, to a more distant or a closer view--for example, using the "page-up/page-down" buttons provided on the PDA. With GPS, the map display is further programmed to scroll or pan over the map in order to follow the moving cursor or other symbol that represent the user's current position, heading, and/or speed of travel. Alternatively, the map display is programmed to shift or move under a fixed cross-hair in order to track a user's current position as detected by the GPS. More capabilities for the GPS to provide controls or contingencies which modify the PDA output of display of map, route, and/or point information are disclosed hereafter--particularly relative to FIG. 9.

Detailed Description Paragraph Right (76):
FIGS. 1B through 1P are screen captures from MAP`N`GO (TM) 0.1 by DeLorme Mapping, Freeport, Me. 04032. MAP`N`GO 1.0 includes an auto road atlas of North America both on CD-ROM and printed in a companion paper map book. The MAP`N`GO 1.0 CD-ROM contains a travel planning software utility embodiment of the present IRMIS invention. This utility enables users to generate digital or hardcopy travel plans from routing operations and selected audio, text and pictorial information on hotels, restaurants, campgrounds and tourist attractions.

Detailed Description Paragraph Right (77):
FIG. 1B reveals the basic user interface, including a map display, and diverse user options for manipulating the electronic maps. Three buttons with diagonal arrows in a row at 130 enable the user to zoom in or out among map scales. Nine buttons in the form of a compass rose at 131 cause the electronic map display to shift or pan to center on a new latitude and longitude. At 134, an overview screen shows the area depicted on the main map in a rectangle in relation to surrounding geography. Mouse clicks in the rectangle further enable the user to shift or pan the center of the map to a different location on the earth's surface. Page numbers and grid identifiers are indicated at 132 for coordinated use of companion paper maps. At 133, the main map scale is shown in terms of "mag" or "magnitude" such that mag 10 offers a closer typically more detailed view than mag 8 or 6, which each present increasingly distant perspectives of larger parts of the earth's surface.

Detailed Description Paragraph Right (78):
FIG. 1C also reveals the basic user interface, including a higher magnitude or closer scale map, as shown at 135. Compared to FIG. 1B, FIG. 1C offers a main electronic map display with more detail including geometric symbols in small rectangles under "Seattle" for example. These symbols represent the availability of supplemental travel information on specific types of locations e.g. Hotels, Campgrounds, Restaurants and Points of Interest. One such symbol indicating a realtime or recorded location as sensed by a GPS receiver interfacing with IRMIS is shown at 136a. As disclosed hereafter, the user can access and manipulate the added multimedia travel information by various mouse or keyed commands.

Detailed Description Paragraph Right (79):
FIGS. 1D, 1E and 1F illustrate assorted locating tools for finding geographic locations, recentering the electronic maps, and selecting specific places or geographic loci as input for routing or multimedia operations. Three buttons in the row at 136 prompt the dialog boxes for "Locate Place Name" at 137, "Locate Zip Code" in FIG. 1E and "Locate Area Code and Exchange" in FIG. 1F. This suite of locating tools facilitates searching lists by the names of places or cities and respective states or provinces as well as locating specified places by recentering the map display upon the identified location.

Detailed Description Paragraph Right (80):
FIGS. 1G, 1H, and 1I express the interface for routing and related operations. The user can access the Manage Route menu or dialog box at 138 by depressing the Route button at 140. A quick pull-down menu at 139 also makes routing or related options available. The user can enter a starting place, e.g., Montpelier, Vt., and a final destination, e.g., Plattsburgh, N.Y., plus intermediate, optional waypoints in between if desired. A suite of buttons at 141 enables the user to add, insert, delete, etc. items to or from the waypoint-input list by routine text and graphic input means. Entered waypoints are symbolized on the map interface by numbered inverted triangles as shown at 147. The user prompts calculation of optimal routes by selecting between Quickest, Shortest or Preferred options at 143 or the 139 quick menu. The resulting route is displayed by highlighting the recommended roads on the map display as shown at 146 from Montpelier through Burlington to Plattsburgh. Added control over routing parameters or variables is provided by depressing Speed 144 and Prefers 145 buttons that access dialog boxes for adjusting the routing computation. The FIG. 1I dialog box allows the user to modify estimated or anticipated speed, or rate of travel, in miles or kilometers per hour for various road classifications. The FIG. 1H dialog box enables the user to calibrate the routing computation module to favor or avoid specified types of roads.

Detailed Description Paragraph Right (81):
FIGS. 1J and 1K further depict routing functionality plus introduce multimedia capabilities. Accessed for example through the 139 quick menu in FIG. 1G, the Points of Interest Along the Way dialog box at 148 in FIG. 1J exhibits a list of three items termed POIs for points of interest in this disclosure. By prompting the Along the Way command, after inputting an ordered list of waypoint input, the user has caused the software to seek and find POIs within a specified distance from the computed route for which further information is available in the form of audio, pictures or text. By depressing either the Show/Tell All or the Show/Tell One buttons on the right in the 148 Along the Way dialog box, the user can prompt a multimedia presentation or series of presentations as shown at 151 in FIG. 1K. Controls along the bottom of the 151 picture display window on Burlington facilitate user control and selection of multimedia content and form, as described hereafter. In FIG. 1J, the Attach button on the right in the 148 dialog box enables the user to pick, fix and include selections of information with travel plan output, as disclosed further hereafter. Travel Plan dialog or list boxes are shown at 149 in FIG. 1J and 152 in FIG. 1K. Travel Plan list boxes are a form of routing computation output including a list of waypoints, routes, compass directions, nearby town, time and distance estimates for route segments and the overall route.

Detailed Description Paragraph Right (82):
FIGS. 1L and 1M further depict information resources about specific types of places. As disclosed hereafter in relation to FIG. 1-O and quick menu 161, the user can access

information on specific types of POIs such as hotels or restaurants. List boxes for local hotels and restaurants appear at 154 and 156 in FIG. 1L and for campgrounds at 158 in FIG. 1M. These listboxes all have a button to Attach information on chosen accommodations to emerging travel plan output. These listboxes also allow the user to call for more detailed information or Full Info on selected locations of the respective types. Such information availability is indicated on the mapping interface by colored symbols within a small rectangle under or adjacent to the relevant place name, as shown for Shelburne at 157. The Campground information box at 159 shows a typical display of Full Info requested by the user concerning the Shelburne Camping Area.

Detailed Description Paragraph Right (83):
FIG. 1N illustrates a typical, moderately complex MAP`N`GO (TM) 1.0 hardcopy travel plan output, as developed in FIGS. 1G, 1J and 1K. Note the heading up orientation of the travel plan, with point of departure at the bottom and destination at the top of a strip map format, as compared with the conventional North is Up and South is Down orientation of the map display in FIG. 1G. The heading up strip map format of the FIG. 1N travel plan has the advantage of a mapping representation in which a route change involving a righthand turn e.g. in Burlington appears intuitively as a righthand turn on the travel plan map. The FIG. 1N travel plan illustrates text travel directions and travel time estimates in hours and minutes along the right margin. Pictorial and text attachments plus estimated miles of travel are presented in the left margin and border of the FIG. 1N strip map.

Detailed Description Paragraph Right (84):
FIG. 1N alternatively shows one or more digital desktop displays. The highlighted route up the center can represent a set of "breadcrumbs", or an actual path of travel logged on an IRMIS PDA/GPS, and transferred to the home-base desktop computer component of IRMIS. Some or all of the digital photos, and/or "map notes" or text POI information boxes, on the left side of FIG. 1N can also reflect PDA/GPS utilization according to the IRMIS invention. For example, the picture of "115 Jones St." could be a digital photo taken with a camera device linked with an IRMIS PDA/GPS in the field. The PDA/GPS recorded the precise date, time, and geographic coordinates of the digital photo for later transfer to, processing and display on the IRMIS desktop. The digital photo was tagged or electronically stamped with the GPS-generated information by the connected PDA/GPS unit, at the time and place it was taken--then transferred from the digital camera to the IRMIS desktop.

Detailed Description Paragraph Right (86):
As shown in FIG. 1P, flexible control over multimedia form and content enables the user of an in-vehicle embodiment of the invention, for example, to maintain an output of audio 169 travel directions for the driver to hear. Meanwhile, the passenger can monitor the visual route map at 170 and, at the same time, browse through information about places to eat in Seattle using the restaurant list box 171. For in-vehicle use, alternatively or in addition, a GPS receiver linked to IRMIS can provide a display of the vehicle's current position as shown as a dot at 173.

Detailed Description Paragraph Right (87):
FIG. 2 is a block diagram illustrating an interactive system 200 which combines computer software processes for routing and travel directions with presentations of multimedia information related to locations. IRMIS works with one or more geographic information systems (GIS) 201 for storage, retrieval, manipulation, mapping, correlation and computation of spatial data related to geographic coordinates corresponding to locations on, above or beneath the surface of the earth within the realm of human activity. The David M. DeLorme U.S. Pat. Nos. 4,972,319 and 5,030,117, exemplify such geographic information systems for generating the map displays and output, as well as management of the geographic databases. Other GIS, or other database systems that relate data with geographic coordinates, e.g., latitude and longitude, also suffice for use with the present invention.

Detailed Description Paragraph Right (89):
Processing starts either with routing 203 or multimedia 204. For example, as a leading step within the routing subsystem 205, a typical application, or episode of use, proceeds with waypoint input 231, typically selected by the user, including a starting place, a final destination and optionally one or more mid-points or intermediate

locations where the user may stop or pass through in his or her travels. Waypoints include departure points and destinations as well as intermediate or mid-route waypoints. Waypoints are listed in the users intended order of travel. The system 200 facilitates waypoint input for routing functions by a variety of means, including database searches, as disclosed for input of points of interest (POIs) within the multimedia block 209. Waypoint input can also be derived from a GPS receiver interfacing with IRMIS, for example, to download the current position of the GPS receiver and input it as a starting point.

Detailed Description Paragraph Right (91):
Based on user-optimized route computations, step 259 next expedites one or more computer displays, graphics, hardcopy, text, audio or other output, representing the initial route as computed along the waypoints input by the user. Such routes are represented as various forms of itinerary including: (1) annotated maps upon which the optimal routes are graphically marked, accentuated or highlighted; (2) lists of waypoints, or place names or geographic coordinates typically arranged in the order encountered along the route; (3) point to point directions how to take the optimal computed route indicating turning points, landmarks, navigation aids, signposts etc. along the computed route also typically arranged in temporal order of travel; (4) one or more POIs or preferrably one or more ordered sets of waypoints or route nodes electronically uploaded into a compatible GPS receiver PDA as shown at 102 in FIG. 1A for portable, remote use (with or without GPS), e.g., for route guidance in the field; (5) various combinations of the four forms of route output or itinerary just listed.

Detailed Description Paragraph Right (92):
As pictured in FIG. 1N, the preferred route output includes map displays or map hardcopy with the optimal route highlighted, marginal travel directions in an easy to follow format with the point of departure consistently at the map bottom, and the destination near the top of the strip map format. Alternative embodiments express such route information output in pure form at step 259 in FIG. 2, by employing other graphics or map formats, images, text and numbers, or sound/voice output to convey the recommended or optimal itinerary or route. Preferred IRMIS desktop/PDA interface is further described hereafter relative to FIGS. 2A, 4C, and 5D-5F.

Detailed Description Paragraph Right (93):
On the other hand, a typical operation or program can begin on the multimedia side 209 with user entry of one or more points of interest (POIs) selected by the user inputting individual POIs or by database searches, sorting for specific predefined types of POI, related characteristics, or linked data or information using the underlying GIS 201. In FIG. 2, to set up a presentation of multimedia place information, the user can perform individual or manual POI input at step 243. For example, a vacation traveler can request multimedia information on two or three popular resort locations recommended by friends, ads or travel articles by using well known data entry methods such as keying in the resort names, or nearest place name, or geographic coordinates. The system 200 is further able to locate individual POIs for input by enabling a user to select from lists of place names, or through linked phone exchange, zip code or geographic coordinate data. The user can engage in manual input of individual POIs by clicking at points, symbols or place names on the map display.

Detailed Description Paragraph Right (99):
The overall system 200, however, enables transfers of intermediate and final outputs between the independent routing 205 and multimedia 209 processes or subsystems. Multimedia and pure routing functions, as just discussed, are blended or integrated essentially by sequencing multimedia and routing operations under user control. Routing 205 plus multimedia 209 subsystem operations, performed sequentially, produce combined or interactive output at step 265. The combined or interactive output typically includes a unique, customized or personalized travel plan provided in the form of map displays or hardcopy maps annotated with information about places, and travel directions, with the optimal computed route highlighted, labeled or otherwise marked. Users can opt to further embellish combined, interactive travel plan output with selected multimedia graphic images, videos, animations, sound or voice output as well as text, documents, numeric or tabular data about locations, POIs or points of interest or other geographic objects along the way, i.e., on or near the computed optimal route. One preferred form of such combined travel plan output is illustrated in FIG. 1N.

Detailed Description Paragraph Right (100):
Combined interactive output 265, routing only output 259, and multimedia--only output 273 can be transferred to and/or from companion IRMIS PDA or PDA/GPS devices. User interaction with routing and multimedia, as illustrated at step 265, gives a combined interactive output that reflects choices made by the user. Step 265 output integrates the user's decisions about waypoint input or routing calculation parameters, plus the user's selection of individual POIs or multimedia inputs derived from database searches, along with the user's interaction with and responses to multimedia presentations. For example, in order to revise or refine his or her emerging itinerary, the user can modify an initial route by altering the current waypoint list adding places he or she really desires to visit, or excluding places from the itinerary, in response to selected multimedia information about the locations found along the initial route. The system 200 further enables users to attach or include multimedia selections to or with travel plan output, i.e., printouts, audio, screen displays, etc. As shown at 265 in FIG. 2, combined output incorporates the user's choices and interests as exercised through one or more interactions with and between the routing 205 and multimedia 209 subsystems.

Detailed Description Paragraph Right (102):
As disclosed in detail hereafter, various input/output transfers and combined routing/multimedia operational sequences take place through the interaction bus 237. Within the middle block 207, the interaction bus 237 facilitates repetitive, looped or iterative operations as well as user interactions producing combined output at step 265 by sequencing multimedia and routing operations. For example, the system 200 enables users to blend pure routing output generated at 259 with subsequent multimedia operations by transferring data via path 261, the interaction bus 237, and path 241 to the multimedia input step 243. In this manner, users can prompt a multimedia experience of information focused upon places found along the way, i.e., within a preset distance of, or in a user-defined region around, an initial route or set of waypoints. Thus in typical operations, the invention 200 sequences prior routing and subsequent multimedia operations to generate route based multimedia information presentations on locations or points of interest along an initial route. Output 259 from prior route computations gets transferred from block 205, the routing subsystem, through the interaction bus 237, over into the multimedia subsystem 209 which then absorbs the route data as multimedia input at step 243. The user can then pick and play one or more multimedia presentations about points of interest or geographic locations found in the vicinity of the current optimal route highlighted on the map display.

Detailed Description Paragraph Right (109):
As detailed hereafter IRMIS 200 enables even more complex operational chains and loops, typically because the user is engaged in replaying selected routing and multimedia steps or operations, usually with minor or modest variations of inputs and parameters, in an effort to refine his or her travel plan. Complex operational sequences also occur because the user shifts back and forth repeatedly between routing and multimedia tasks, for example, to play multimedia information related to routes and waypoints appearing on the map display, or to revise their travel plans by altering the current list of waypoints in response to multimedia information about places and POIs.

Detailed Description Paragraph Right (111):
The user can opt for a quick and simple routing operation or extensive travel planning with multimedia input. For example, a user can employ the system 200 just to input Boston as a point of departure and New York as a final destination, then compute the quickest route for automobile travel between the two cities. Given more leisure time, however, the user can elect to proceed with the invention 200 to experience multimedia about points of interest around the quick car route to New York from Boston, or to explore and compare rail, air or marine routes between these two cities. Moreover, in response to the multimedia experience, this user can plan various side trips, or a much more convoluted route incorporating intermediate waypoints, including places the user wants to visit. Furthermore, the user can choose to compute a combined transportation route, for example, driving by car from Boston, Mass. to Providence, R.I., then taking a train to New Haven, Conn., with the journey on to New York City completed by bicycle, or on foot.

Detailed Description Paragraph Right (112):
After making an extensive travel plan, including more side trips or stop-overs than available leisure time, the user can opt to edit or revise down an overambitious travel plan. This task of prioritizing or selectively reducing a travel plan entails yet another series of multimedia presentations and routing computations, aimed at the discriminating elimination of the intermediate destinations of least interest to the user, and the side trips or modes of transportation which involve too much travel distance or travel time. This disclosure employs the shorthand notation explained above in order to help express or describe such complicated sequences of multimedia and routing operations in relation to the FIG. 2 block diagram, or more detailed flow charts presented hereafter.

Detailed Description Paragraph Right (113):
Importantly, the shorthand notation aids the user in understanding that the invention 200 facilitates a diversity of repeated or combined software operations. The interaction bus at 237, within the interaction block 207, enables pure sequences of iterative operations e.g. a series of routing operations only, as well as sequential combinations of mixed multimedia and routing operations. By taking or following different paths through the interaction block 207, for example, the user can either recycle a pure routing operation, with deliberate variations, or combine antecedent routing output with subsequent multimedia operations to produce presentations of information in various media related to the prior routing output. Vice-versa, the user can repeat a pure multimedia operation varying significant details. Or the user can invoke an ensuing routing operation, after a multimedia presentation about locations or geographically located objects, typically in order to plan and map out optimal travel routes and transport between selected places or points of interest experienced by the user in the multimedia.

Detailed Description Paragraph Right (120):
For example, the user might proceed to compute an optimized route from home to the one resort location most preferred by the whole family. This entails transfer of POI data on the selected resort from the multimedia subsystem 209 into the waypoint-input module 231. There the user can input the resort location, or the nearest routable node, as the ultimate travel destination. The user's home address is entered as the point of departure. Then, in step 245, the user can prompt the computation of the quickest, shortest or another optimized route, as detailed hereafter. In combination with prior multimedia tasks developing a short list of resorts, this one simple follow-up routing computation expands the overall formulation to the following: M1, M2, M3, R1=C01. The first three multimedia operations can also be expressed in terms of their pure output M03, which the user can elect to save for later comparison and/or added processing. Thus, the overall sequence of combined routing and multimedia can be equivalently and compactly formulated as: M03, R1=C01. In any event, C01 stands for a combined output rather than pure output. Following up the antecedent multimedia selection of resort locations, the routing operation R1 proceeds by way of steps 245 and 257, then path 247, through the interaction bus 237, down path 263 to step 265. There it becomes the C01 combined output, typically in the form of highlighting the optimal computed route from the user's home to the selected resort on the underlying map display.

Detailed Description Paragraph Right (124):
Along with the capability to modify multimedia and routing parameters and content, the invention 200 provides user control over operational sequencing and combinations, facilitating the production of individualized, custom, or personal travel plans. This disclosure uses the terms "individualized, "customized" or "personalized" to characterize output generated with substantial user interactivity. Even in the example previously cited, where the user only opts to compute the quickest automobile route from Boston to New York City, the user exercises choice over the point of departure and the travel destination. More user interactivity productive of custom output is illustrated by the added selection of intermediate waypoints, such as Hartford Conn. and Providence R.I., and the specific order of travel between waypoints. User choices or interaction are also enhanced by the capability for comparison of varied routing parameters e.g. scenic or shortest route and varied modes of transport e.g. rail, bus, ferry, air as well as automobile travel. The invention further enables individualized or custom output by facilitating unique iterative, sequenced and combined multimedia

or routing operations, according to the user's responses and preferences while operating the system 200.

Detailed Description Paragraph Right (125):
Customizing travel plans through the selective exercise of user controls over the sequencing and combination of operations was already exemplified above in the case of the resorts picked first in the multimedia subsystem 209. The user could proceed thereafter with various scenarios for follow-up routing tailored to user requirements and preferences. Comparing and evaluating alternate destinations and routes enabled the user to develop or refine individualized travel plans, reflecting "roads not taken" or selectively deleted waypoints as well as explicit travel information. Such customized travel planning often entails some operational sequences being repeated with the user varying the format, content, media and parameters involved in succeeding operations. Such systematic variations help the user to decide about alternative waypoints, transport, points of interest, or variable informational forms and content, in order to compose a personal travel plan. Travel planning is typically individualized by the user controlling transfers and integration of data between the multimedia 209 and the routing 205 subsystems by means of user selectable pathways through the interaction bus 237. For instance, individualized travel plans are further facilitated by operational sequences, commencing in the routing subsystem 205, which are then combined with presentations in the multimedia subsystem 209.

Detailed Description Paragraph Right (127):
FIG. 2 depicts the flexibility or user options as provided by the invention 200 for variable or custom sequences of routing and multimedia operations. For one instance, having done no more than enter Boston as the starting point plus New York City as the final destination in the waypoint input module 231, the user can choose to transfer operations and data via paths 233 and 241, and prompt multimedia presentations on the attractions, accommodations and other geographically located information about Boston or New York City, which are stored in the IRMIS database. This option is further described in relation to FIG. 4, particularly step 431. Alternatively, the user can opt to transfer to the multimedia 209 only after computing and displaying an optimal route from Boston to New York through steps 245 and 259 in FIG. 2. Then, paths 261 and 241 enable access to a variety of subsequent multimedia about Boston, New York City, or points of interest or POIs found along or within a certain user-defined region around the optimal route. FIG. 4 especially step 471, FIGS. 5, 6A and 6B, and related text, further specify this process whereby POIs are found or located along the way or within a user-defined distance from a computed route or its component waypoints. In sum, the sequences of operations discussed in this paragraph generally reduce in the shorthand notation as follows: R1, M1=C01. The one multimedia operation, following one prior substantial routing computation or waypoint input operation, logically generates combined output 265 via path 251, the interaction bus 237 and path 263.

Detailed Description Paragraph Right (134):
FIG. 2A shows the steps of user selection, automated data extraction, cutting, compression, coordination, and elimination of duplication which proceed transfer of dataset(s) of map, route, and/or point information from IRMIS home-base desktop to portable PDA for use in the field.

Detailed Description Paragraph Right (135):
FIG. 2B illustrates transfer of GPS log records and/or POI location marks and annotations from PDA respectively to the route and point data processing parts of the desktop GIS or geographic information system. At 295 and 298 are illustrated the process of "hot-synching" or the automated one or two way coordination or "updating" of one or more selected, corresponding dataset(s) in a linked PDA and desktop.

Detailed Description Paragraph Right (136):
In FIGS. 2A and 2B, the desktop or home-base component of the IRMIS invention is represented by the larger boxes--at 281 and 282 respectively--corresponding to the interactive routing and multimedia POI system at 200 in FIG. 2 for user-customized travel planning and/or geographic data selection. The portable PDA component of the IRMIS invention is shown in FIGS. 2A and 2B at 282 and 284 respectively. As described elsewhere in this disclosure, the PDA at 282 and 284 is typically utilized in the field, or at locations remote from the desktop; the PDA is often and preferably used in conjunction with a GPS receiver, or some equivalent.

Detailed Description Paragraph Right (137):
In FIG. 2A, the desktop geographic information system for routing and multimedia operations preferrably comprises a large-scale (e.g. national) map and point information database. The user considers and selects points of interest, computes optimal route and travel plans often by repeated iterations and editing, and at the user's option chooses and attaches multimedia or POI information--at 285. The user can then opt to transfer one or more map, route and/or point information "packages" or datasets into the companion, portable PDA at 290.

Detailed Description Paragraph Right (138):
At 286, in response to the user command to load the PDA, the inventive IRMIS software cuts or extracts the map, route, and/or point information selected by the user, and "packages" it for use in the PDA. This process of cutting or extracting a geographical information subset collects data from one or more map screens--including information on POIs and routes picked by the user, as further detailed hereafter particularly relative to FIG. 5F.

Detailed Description Paragraph Right (139):
At 288, the IRMIS invention proceeds to make the dataset(s) more compact and adapted to use on the PDA. For example, color maps are adapted for use on gray-scale PDA map displays removing unnecessary color data which would waste PDA memory; alternative symbols, legible in black-and-white, may be substituted for vital map or symbol color-coding. Users typically select more than one package for PDA--often including overlapping maps and alternate routes to or from a particular location. Such multiple packages are coordinated or cross-referenced, and PDA memory requirements are reduced by elimination of duplicate records, as detailed more hereafter, particularly relative to FIG. 5F. The dataset(s) or packages are then transferred into one or more PDAs 282 at 289 and 290--for portable remote use.

Detailed Description Paragraph Right (140):
In FIG. 2B, such a PDA 284 is shown after field use. For example, the PDA user may have deployed the GPS log to record a set of breadcrumbs or a series of geographic points at some user-specified time/distance intervals along an actual route or path of travel taken the user with the PDA. One or more accumulated breadcrumb trails or GPS log dataset(s), stored in the PDA at 293, are readily transfered into the more fully articulated 291 routing subsystem within the desktop 283 in FIG. 2B. This 291 routing subsystem in FIG. 2B corresponds to 205 in FIG. 2A, wherein the GPS log data can be displayed, used in further trip planning or analysis, or otherwise processed using the powerful desktop.

Detailed Description Paragraph Right (142):
As shown at 297 and 298, such transfers between the PDA and desktop can be one-way, at the user's option, or programmed for automatic transfer whenever the PDA "docks" or connects with the desktop. The two-way arrow at 299 illustrates "synchronization" i.e. automated two-way or mutual updating of specific, congruent dataset(s) in the desktop and PDA e.g. "Set A" at 296 and at 295 respectively. Thus, changes in the user's address book, travel plans, map configurations, and/or point information can be made to match on both the desktop and PDA. "Synchronization" of this kind can be one-way, two-way, automatic, and/or subject to user confirmation. For example, the IRMIS PDA might be programmed to automatically transfer any and all new digital photos--the date, time and location--taken by a digital camera, connected to and used in conjunction with the IRMIS PDA/GPS in the field.

Detailed Description Paragraph Right (143):
FIG. 3 is a flow chart illustrating the organization and procedural logic of the commands or user options available to multimedia users of the preferred embodiment of IRMIS. The system combines multimedia and routing to provide a software utility for personal and business travel planning. FIG. 3 depicts data transfer pathways as well as the hierarchy of commands and user options available to users in the Points of Interest system listbox or dialog box shown in FIG. 1J. In the multimedia mode, the user can call up this dialog box on top of the map display that typically dominates the computer screen.

Detailed Description Paragraph Right (147):

Either to start a fresh pure multimedia presentation or to modify one or more pre-existing POI lists, the user proceeds from C to step 319 in order to get and decide on POI inputs in several ways. Users can get and manually enter one or more POIs typing in place names, geographic coordinates or other literal location indicators. The user can also seek, pick or delete POI input by browsing lists of locations, or other situated data, and choosing points of interest. Moreover, the user can employ cartographic or graphic means in order to locate potential POIs to be added to or deleted from the current POI input list. This typically is done by positioning the cursor on locations, symbols, geographic coordinates, place names, etc. on the current map display. The user can manipulate the cursor position on the map display with the mouse, arrow keys or other means in order to recenter the map display, causing it to shift or pan laterally to a new location centered on a different latitude and longitude. In summary, the "GET POI" operations at 319 include user options to add, delete and rearrange the POI input list along with shifting or recentering the map display on the current POI. Users can also opt for zooming down to a closer map scale for a more detailed perspective or zooming up or out to get a more global outlook covering larger territory. IRMIS utilizes such flexible and intuitive capabilities to zoom among map scales or shift across digital maps, seeking POI input, with map generation and cartographic database technology as disclosed in the David M. DeLorme U.S. Pat. Nos. 4,972,319 and 5,030,117. The user can also shift, or recenter, map displays to locate POI inputs by entry of telephone numbers, zip codes, street address information and other located or locatable data. IRMIS provides several textual or graphic methods for the user to get POI input by means of selective commands and procedures made available at step 319. The system also enables the generation and modification of lists of POI inputs by various methods for database searching and sorting well known in the art of computer programming.

Detailed Description Paragraph Right (154):
At 309, in FIG. 3, the user develops or alters his or her travel plan or itinerary by attaching selections of multimedia, as experienced in a Show/Tell operation. Such travel plans or itineraries are composed in IRMIS in part by the attaching of multimedia information about places and locations to the underlying map display on which is highlighted previously computed optimal route output. FIG. 1N illustrates one example of such travel plan output, adorned with annotations, pictures, and graphic arrows concerning points of interest as selected by the user in response to multimedia presentations on those locations or POIs, generated by IRMIS preferred embodiment. Different, more advanced embodiments facilitate attachment and location of audio or video output, experienced in the multimedia mode, on digital travel plan outputs combining multimedia and routing as detailed elsewhere in this disclosure. Step 309 enables the user to transfer selected multimedia through M to be attached to an itinerary or travel plan, as depicted in FIG. 1N, by processes described hereafter in relation to FIG. 4.

Detailed Description Paragraph Right (155):
In the lexicon of this disclosure, attaching multimedia refers to the process of picking, transferring and displaying multimedia about particular POIs or locations through the interaction block 207 for inclusion upon travel plan output at 265 with reference to FIG. 2. Attached multimedia can comprise text annotations about POIs with graphic arrows or pointers indicating the site or geographic location of specific POIs on travel plans in the form of map hardcopy or map display output on which one or more routes are highlighted, as shown in FIG. 1N. Other embodiments enable attachment of still or moving images, sound, and various other media to travel plan output. Though such multimedia attachments invariably modify the informational content of travel plans, the definitive feature of travel plans with attached multimedia is that the highlighted computed optimal routing component has not been altered by modification of the waypoint lists.

Detailed Description Paragraph Right (157):
Step 315 in FIG. 3 does facilitate transfer of POIs picked by the user, experiencing multimedia information about such POIs, over to the routing subsystem 205 to be transformed into a new, or modified, list of waypoint input in order to prompt a new, or a revised or recycled, routing computation as described relative to FIG. 4. In contrast to merely attaching prior multimedia information to travel plans by way of step 309, through step 315 IRMIS user is able to add or delete new waypoints and highlight a newly computed optimal route based on his or her experience of,

interaction with and responses to multimedia place information. This new or altered highlighted route output can appear at the user's option without any supplemental information from the preceding multimedia added to the user's itinerary. The user can also opt to include annotations, or alternate selections from the prior multimedia, embellishing the resultant travel plan output, along with the optimal route encompassing new waypoint selections, based upon the user's multimedia experience. In sum, step 315 provides preferred travel plan output where the user wants a new optimal route computed in response to multimedia about new locations.

Detailed Description Paragraph Right (162):
FIGS. 4A,4B, and 4C are assembled to form the flow chart referred to hereafter as FIG. 4. FIG. 4 is a flow chart illustrating the processes and user options included in the routing mode of a preferred embodiment of IRMIS. The system is a component software travel planning tool which combines multimedia and routing. FIG. 4 relates to the operational sequences, data transfers and user controls implemented by way of the Manage Route dialog box depicted at 138 in FIG. 1G. The user can access this suite of tools, commands and processes, invoking the routing mode of operations, by calling up the Manage Route dialog box on top of a portion of the map display which pervades the computer screen in typical applications of the system.

Detailed Description Paragraph Right (166):
In FIG. 4, steps 406 and 409 mean that the user can opt to exit from or close the waypoint input module. Like virtually all operations embodying the invention, waypoint input is achieved on top of a computer map display, which becomes part of the waypoint input interface, as described hereafter. In the lexicon of this disclosure, waypoints are route input items including one point of departure, one final destination and, optionally, one or more intermediate loci entered in order of travel. Waypoints are highlighted as input with inverted green triangle symbols on the map display as shown at 147 in FIG. 1G. As entered, waypoints also appear on a list in the order to be encountered on the intended journey, as shown in the Manage Route dialog box illustrated at 138 in FIG. 1G. The list of waypoints arranged in planned order of travel in the Manage Route dialog box corresponds to step 411 in FIG. 4. The user works in the waypoint entry module or command suite until he or she elects to close the function at 406 and 409, or to compute a route at 433, or to transfer waypoint input through 431 in order to experience selected multimedia information about the waypoint locations and nearby places.

Detailed Description Paragraph Right (167):
Consistent with methods for the management of ordered lists well known in software, the module for waypoint input enables the user to add one or more waypoints to the end of the waypoint list at 413, clear all waypoints at 415, or delete one or more waypoints at 417. Routing requires at least a starting place and a destination, i.e., at least two waypoints. Step 419 recycles empty or single item waypoint lists for further input to meet this requirement. Step 421 facilitates the insertion of one or more new waypoints at places chosen by the user between or before other waypoints on a preexisting list. In this way, the user can amend a waypoint list starting out from Boston going to New York City by inserting Hartford en route. Or, the user can insert Los Angeles or Mexico City as intermediate stops or places to pass through on his or her planned trip departing from Boston and ending in New York City. After specific waypoints have been cleared, deleted or inserted, steps 423 and 425 implement those changes by rearranging the current waypoint list in accord with the user's revised or amended order of planned travel.

Detailed Description Paragraph Right (168):
Even entry of a fresh waypoint list can cycle several times through H while the user is engaged in revising his or her initial input. Moreover, the waypoint entry module also enables the user to edit and alter a waypoint list from which an optimal route has already been computed and displayed. In such cases, a user adds, deletes or inserts waypoints relating to a previously computed route. Then steps 427 and 429 function to clear away the old route display, anticipating a new route computation that will incorporate the user's new waypoint list based on revision of the old waypoint list.

Detailed Description Paragraph Right (169):
The system enables input and alteration of waypoint lists by means of an array of list

based locating tools that can search zip code, phone exchange and place name indexes, as shown in FIGS. 1D, 1E and 1F. The map display recenters on new locations thus selected by the user. Also, the user can employ graphic/cartographic means for the selection of waypoints and related manipulation of the map display. For an example, users can choose waypoints by pointing and clicking upon symbols or place names or at specified pixel locations on the digital map display which correspond to geographic coordinates of places or objects situated on or adjacent to the earth's surface. Graphic, intuitive waypoint input location is further facilitated by capabilities to zoom amongst map scales and detail levels as well as panning or shifting to recenter the map display upon a different place or set of geographic coordinates.

Detailed Description Paragraph Right (170):
In alternate embodiments of IRMIS and enhanced commercial versions, routing or waypoint input can encompass airports plus flight paths, bus stations and bus routes, railroad terminals and tracks, subways and other urban transit systems, offroad vehicle travel, trails for bicycles, hiking and other pedestrian paths as well as oceanic, coastal and inland shipping channels, also boat launches, portages and river passages for canoes or rafts, plus other commercial and recreational transport and travel means. Even more generalized point-to-point routing more or less "as the crow flies" over rasterized or digitized computer maps can be added. The present system is applicable to a broad range of point and vector data structures familiar in the routine arts of geographic databasing and digital cartography including but not limited to the foregoing specific input/output formats for waypoints or POIs as detailed in relation to FIGS. 5, 6A and 6B.

Detailed Description Paragraph Right (171):
The system technology is designed to take user travel planning requirements into account. Waypoint inputs are ordinarily structured. First on any waypoint list is a single point of departure. By definition, waypoint lists end with one final destination. In between, stops and places to pass through picked by the user are arranged in the order of intended travel. Thus, a first waypoint list consisting of Boston, Hartford, New Haven and New York City is not the same for example as a second waypoint list which calls for leaving Boston, going to New Haven, then Hartford, on the way to New York City. Waypoints are input in an ordinal or serial data structure which is a representation of the user's intended order of travel: (1) first, the starting place; (2) second, initial intermediate waypoint; (3) third, next stop or waypoint; N-1th intermediate waypoint; and Nth waypoint, final destination or end of planned journey. Intermediate waypoints are optional, of course, but get entered in a specific order corresponding to the user's intended itinerary. Even before any computation of the optimal routes between a set of waypoints, waypoint input is already arranged in a data format descriptive of the user's overall planned itinerary.

Detailed Description Paragraph Right (173):
This disclosure confines the term routing output to output from computation and display operations at steps 433 through 453, as detailed hereafter. Waypoint input operations, transferred to multimedia via step 431, still qualify nonetheless as substantial routing steps or operations for purposes of making up a valid set of routing and multimedia operations combined in sequence within the inventive technology. This is because ordinarily structured waypoint input can be distinguished from random location data, or even from a list of POIs selected manually by the user or from a database search based on personal interest or links to specific topics or subject-matter. Waypoint input describes the user's point of departure, planned stop-overs or intermediate waypoints and ultimate destination in order.

Detailed Description Paragraph Right (176):
Similarly, service and delivery personnel can plan their work for the day or the week on the road. Appropriate databases can help identify prime properties or security trouble spots. Real estate or security agents can input the street addresses or other location identifiers from the database in order to compose a waypoint list as input for the computation of an optimal route encompassing the properties of interest to the agents. With the waypoint list at step 411 and the background map display, alternate embodiments of the invention incorporate a variety of well-known databasing methodologies in order to enable the user to design, implement, output and further process diverse searches for waypoint input. In like fashion, waypoint lists can be

memorized and recalled for later use or modification.

Detailed Description Paragraph Right (177):
Such service and delivery personnel will find the IRMIS PDA and/or PDA/GPS devices particularly useful. After using the IRMIS desktop for more complicated client and/or address list processing, and one or more iterations of related route-planning, the delivery or sales call route(s) for the day or week can be selected, refined, compacted and transferred to compatible portable IRMIS PDA or PDA/GPS devices, as detailed particularly relatively to FIGS. 2A and 5D-5F in this disclosure. Then, the sales or service workers can take the IRMIS PDA or PDA/GPS device--loaded with one or more sets of map, route and/or point information, along on the road, e.g., for route guidance. Moreover, the portable IRMIS devices can be used in the field to track actual paths of travel, to mark locations, and/or for point information annotations, which data as recorded at remote locations can be transferred to the IRMIS home-base desktop for further display and processing, as detailed herein particularly relative to FIGS. 1A3 and 2B.

Detailed Description Paragraph Right (178):
Step 411 and the map display interface also facilitate the processing of canned or prepackaged sets of waypoint inputs in addition to individual ad hoc waypoint input lists made by users planning personal travels in the waypoint entry module. Thus, the present invention enables processing by the user of prepared lists of particular types of museums or recreational facilities, for example, with database links to the pertinent street addresses or other location identifiers such as latitude/longitude. The user may purchase such digital lists of potential waypoints on software media e.g. diskette, CD-ROM, PCMCIA cards etc. as a data accessory for use in the system. Such prepackaged lists of waypoint inputs can also be downloaded via modem from another computer or a central service bureau. Such pre-recorded lists include sets of business or residential names and addresses linked to certain financial or demographic data. Alternatively, an off-the-shelf travel plan might include a recommended list of waypoints for a selected region or user interest. Utilizing the waypoint entry module, the user can then modify or personalize and customize such prerecorded waypoint lists. To assist with the task of individualizing a canned list, the user can invoke step 431 to consult selected multimedia information concerning the predefined waypoints, nearby resources and attractions.

Detailed Description Paragraph Right (180):
For example, the July 1994 release of the MAP`N`GO (TM) 1.0 on CD-ROM included a preferred embodiment of the invention, in the form of a travel planning utility, which computes quickest, shortest, or other preferred or optimal routes along major auto roads and selected car ferries. This embodiment represents the available routes as certain line segments on map displays which are drawn between the routable geographic points generally termed "nodes". The MAP`N`GO (TM) 1.0 travel planning utility treats the following geographic points as possible waypoints or nodes: (1) major road and highway intersections; (2) the junctures or turning points of connected line segments representing the major auto roads and highways; (3) place names situated right on major auto roads and highways; and (4) POIs located on or immediately adjacent to the major roads or highways. To facilitate and speed routing computations in this embodiment, every possible waypoint or routable node is stored in the IRMIS database on the CD-ROM in association with a list of all immediately adjacent nodes and the precalculated distance thereto. The July 1994 MAP`N`GO (TM) 1.0 travel planning utility computes optimal routes between selected and ordered lists of nodes or waypoints employing routines based on the Sedgwick-Vitter algorithm disclosed in James A. McHugh, Algorithmic Graph Theory (Prentice Hall 1990) pp. 107-108. This embodiment permits the user to adjust parameters for the routing computations, such as speed settings and preferences for/against certain road types as disclosed hereafter. The present technology works, however, with other transport system databases, various types of routes and definitions of routable nodes as well as alternative routing algorithms and adjustable parameters.

Detailed Description Paragraph Right (181):
As shown in FIG. 4, new or recycled routing computations follow input, recall or alteration of a particular waypoint list including a selection of routable nodes which are arranged in an ordinal array according to the user's intended itinerary or order of travel. Provided with input of at least two waypoints, including one point of

departure and one destination, step 433 enables the user to select and execute various routing computation options. The system facilitates the following alternative route computations: (1) Quickest, i.e., the route estimated to take the least time to travel between entered waypoints, even if over a longer distance on faster roads (step 437); (2) Shortest, i.e., the route which is the least distance in the actual miles or kilometers, etc. one must travel even if the route takes more time to travel on slow roads (step 438); and (3) Preferred, i.e., the user can select various road conditions or types to favor or avoid, such as toll roads, forest roads and routes involving car ferries (step 439). The Manage Route dialog box, shown in FIG. 1G, facilitates user choice among the foregoing criteria or variables for routing computations.

Detailed Description Paragraph Right (182):
The Manage Route dialog box in the July 1994 MAP`N`GO (TM) 1.0 travel planner embodiment also provides access to a Preferred Routing dialog box, shown in FIG. 1H, enabling the user to favor or avoid the following road types: limited access roads; toll roads; national highways, primary state or provincial roads; lesser state and provincial roads; major connectors; forest roads; and ferries. The Global Speed Setting dialog box in FIG. 1I enables users to adjust the estimated or expected speed of travel on each the foregoing road types in response to user preferences or expectations with regard to a leisurely pace or need for haste, weather, traffic, construction or vehicle problems which the user might anticipate.

Detailed Description Paragraph Right (183):
In FIG. 4, steps 440, 447, 449, 450, 452, and associated paths relate to the menus or dialog boxes which enable users to choose various routing computation options such as Quickest or Preferred routes as illustrated in FIGS. 1H and 1I. Whenever the user elects to alter such routing computation variables, IRMIS loops or returns the user to the connector H in FIG. 4 thereafter, giving the user a chance to modify the waypoint list content or not. Then, the user can go to step 433 to implement the altered routing computation. When the user chooses a new routing computation option, for example to avoid one or more types of road in step 443, then step 447 determines whether there is any current route display needing to be cleared away or removed in step 452 before returning the user to H. Steps 449 and 450 administer similar display housekeeping chores in the cases where the user opts to adjust the speed on certain road types in step 441 or to favor selected road types in step 445. In other words, if the user modifies parameters for routing computation in step 440, after any necessary clearing of old displays in 452, the user is returned to step 433 through H for execution of the new form of routing computation, with its new criteria for routing e.g. Quickest instead of Shortest route. The system defaults to computation of the quickest route through step 433 in the absence of the user picking another parameter. Steps 438 and 439 reflect routing computation options or variables elected by the user through step 440.

Detailed Description Paragraph Right (184):
Other embodiments of the system provide further parameters or options for optimal routing computations. Scenic routes can be identified in the database of highways, roads and other modes of transport such that a minor routine modification of the overall routing algorithm program then enables the user to prefer roads and transport which afford natural vistas and ample opportunities for sightseeing. Similarly, enhancements to the route database can address highway width, clearance and load factors such that the routing algorithm, with minor alterations, can output travel plans suited to the specialized requirements of truckers and heavy transport. Using programming techniques well known in the field of geographic information systems and digital cartography for managing located statistical data expressed in the form of map overlays, routing computations can be integrated with databases relating geographic locations with a broad range of situated conditions. Thus, users of the present invention can choose an optimal route computation which prefers or avoids high crime areas, particular environmental or weather conditions, residential versus industrial or rural as opposed to urban areas, even geocoded demographic or economic factors, provided the embodiment is linked to the appropriate databases.

Detailed Description Paragraph Right (185):
Steps 453, 455, 457, 459 and 461 in FIG. 4 constitute the module for routing output and display including pertinent user options and adjustments. Insofar as no multimedia is combined with routing, step 453 corresponds with step 259 in FIG. 2, i.e., routing

output only. But, to the extent that prior multimedia operations and outputs are mixed or combined with a specific routing operation through path 403, steps 465 and 467, then step 453 in FIG. 4 parallels step 265 in FIG. 2. In such cases, step 453 produces output from combined multimedia and routing, mediated by user responses and interaction, involving at least one preceding multimedia operation integrated with at least one ensuing substantial routing operation. For example, a prior multimedia output can get attached to otherwise pure routing output through step 465. Such attached multimedia selections typically include a marginal annotation or digital image with an arrow symbol or graphic pointer indicating a pertinent location on the map display as illustrated in FIG. 1N.

Detailed Description Paragraph Right (186):
For another example of combined operation output at step 453, path 403 facilitates the user transferring POI data from the multimedia subsystem 209 through the interaction subsystem 207 to become new waypoint input, either expanding or shortening the current list of waypoint inputs. Any resulting routing computation and its ensuing output at step 453, which are based on this new list of waypoints, therefore incorporate the user's responses to and interaction with the preceding multimedia transferred to the routing subsystem 205 via path 403. Relative to route output/display at 453 in FIG. 4C, IRMIS embodiments preferably provide users with some control options or command means (dialog boxes, menus, keystroke sequences, . . . etc.) in order to select various outputs or output combinations. Thus users can select levels of detail, various map printouts and displays, text directions, lists of attachments, supplemental information on POIs, audio and/or graphics. At 463, users can additionally or alternatively command IRMIS electronic digital output: e.g. (1) transferring map, route, and/or point information into an IRMIS PDA interfacing the IRMIS desktop--for portable use in the field; or (2) transmission of IRMIS output to other computers. IRMIS invention further facilitates transfer of point information, like multimedia on POIs, to portable IRMIS devices from the IRMIS desktop or home-base. Such map, routing and/or point information can be used on one or more IRMIS PDA devices (with or without GPS).

Detailed Description Paragraph Right (187):
As described hereafter in relation to FIGS. 5, 6A and 6B, step 467 in FIG. 4 readjusts the radius or, more generally, the size of the area around intersections or nodes along a computed route within which the travel planning utility looks for POIs as topics for multimedia presentations. This technical process of resetting the geographic area to be searched for multimedia POIs comprises a substantial multimedia operation for combination with routing insofar as readjustment of the radius or POI search area impacts on a map display also exhibiting route output. Resetting the radius or the size of the region searched for POIs impacts on route display/output substantially whenever it causes POIs to be added or deleted from the map display and the related POI list as detailed in relation to FIGS. 5, 6A and 6B.

Detailed Description Paragraph Right (188):
Steps 455, 457, 459, 461, and 463 enable the user to choose among formats for the routing display/output at 453 in FIG. 4. These steps correspond with the more general options for mixed or pure routing output available to the user in steps 215 and 211 in FIG. 2. As shown in FIG. 4, the user options selected through step 455 are controlled through dialog boxes, menus, text commands and other routine user interface technologies. Step 457 enables the user to prompt route output in the form of a voice or text list of waypoints presented in planned order of travel with or without verbal or literal travel directions and other located information associated with items on the waypoint list. Step 457 also allows the user to opt for such audio or text output either in conjunction with or in lieu of the map display or visual route output.

Detailed Description Paragraph Right (189):
For example, while driving, the user of an in-vehicle embodiment can turn off the map display as an unnecessary visual distraction, using step 457 to retain spoken output about waypoints, route directions as well as other located audio information pertaining to places along the way. Step 457 also permits simultaneous audio-visual output, for example, so that the driver can listen to audio output about his or her travel plans while a passenger is also looking at the highlighted route and other information on the map display as illustrated in FIG. 1P. Step 457 further permits turning off the audio output so the driver and passenger can listen to music or

converse while the passenger keeps an eye on the visual map/route display. Further details on audio/visual options for multimedia output, which can be combined with routing output at 453, are disclosed in relation to FIGS. 7, 8A-8E. Software control of IRMIS output/display format and/or contents on portable IRMIS devices, based on GPS/route variables, is further described in relation particularly to IRMIS FIG. 9.

Detailed Description Paragraph Right (190):
Accessed through step 455 in FIG. 4, step 459 offers user options and controls related to combining multimedia selections with routing output by attaching text, numbers, visual images or sounds or voice. As earlier stated, attaching multimedia refers to processes whereby selected information about locations gets included with map output, but without changing the waypoint input list. For example, the system attaches annotations in the margins of standard strip map travel plan output, as shown in FIG. 1N, with graphic arrows indicating related locations on the background map. A typical text annotation includes the name, address and phone number of a cultural event or attraction: e.g. "Pole-O-Moonshine State Park U.S. Route 9 (518) 834-9045". An arrow stretches from the box containing the text in the margin of the map, pointing out this park's location in Keeseville, N.Y. over on the map portion of the travel plan in FIG. 1N.

Detailed Description Paragraph Right (191):
Such text annotations can attach a broad variety of data and information to map locations including historic facts, environmental data, personal commentary, demographic, economic or political intelligence, news, even ads, jokes, folklore or fictional accounts relevant to the particular location and potentially of interest to the user. By its nature, however, attached information provides supplemental information about places or objects located on or near some pre-existing route display/output. In the example above, the state park is not made a new waypoint, i.e., it is not treated as a new waypoint input. Rather, the location of the park is pointed out near or along the route display with supplemental information about the park presented in a marginal text annotation. Attach "buttons" are shown for Hotels and Restaurants in the 154 and 156 dialog boxes in FIG. 1L, also for campgrounds in the 158 dialog box in FIG. 1M.

Detailed Description Paragraph Right (192):
The present invention facilitates other forms and methods to attach information about locations. For example, to enhance a hardcopy travel plan for making sales calls on the road, step 459 facilitates attaching digital photos of sales prospects beside marginal notes detailing their name, personal interests and past purchasing history. This located information aids the user not only to find sales prospects' locations but also to recognize the prospects' faces, remember names and create a more effective and personable impression. Similar attached photographic imagery proves useful with various travel plans: (1) photos of landmarks as navigation aids; (2) digital pictures of drop-off sites, loading docks and other shipping terminal facilities to aid truckers and other delivery personnel; (3) images of industrial facilities, homes, buildings and land as seen from the road to enhance travel plans for real estate surveys, private security, public safety, etc.; and (4) attached digital photos enhance scenic or sightseeing travel plans. FIG. 1N illustrates attached digital photos of people and property. Attached images of faces, places or other located content are not limited to still digital photo imagery except in hardcopy output. The system enables attachment of videos, extensive alphanumerical text or voice information about places or POIs, or situated music or natural sounds to map/route displays and electronic output.

Detailed Description Paragraph Right (193):
Along with the marginal note or image box format, attached material can be accessed by clicking the cursor on an appropriate symbol located upon the map/route display. Attached visual and audio material related to the place picked by the user can then be played selectively on the full screen, interrupting the map display for a brief or lengthy time period, at the user's option. In the alternative, the user can attach multimedia selections about locations appearing in windows superimposed upon map/route displays as illustrated at 162 and 165 in FIG. 1-O. These can also be printed out in hardcopy covering portions of the underlying map, as well as in marginal notes or accessible alternative screens.

Detailed Description Paragraph Right (194):
Contrasting with attached multimedia, step 461 in FIG. 4 facilitates combined map/route displays and output whereby the locations or POIs selected by the multimedia user do become new waypoint or routing inputs. In effect, step 461 enables the user to choose a routing display/output format which adds, deletes or inserts POIs selected by the user in multimedia using the module for waypoint input. Instead of just attaching multimedia information about places along a pre-computed route, step 461 causes entry of locations picked by the user in response to multimedia as new waypoint input. Step 461 reformulates the current waypoint list by recycling operations through H. Unless the user chooses otherwise, new waypoints are inserted after or before the closest old waypoint in accord with the user's old order and direction of travel. This new waypoint input in turn prompts a new route computation through step 433 resulting in a corresponding new route output at step 453. Step 461 provides a preferred means for combining routing and multimedia output in cases where the user desires or requires computation/output of a new optimal route based on a new revised waypoint input list including or eliminating locations according to selections by the user made in response to his or her experience of multimedia concerning those locations.

Detailed Description Paragraph Right (196):
Whatever the format and content of a step 453 route output/display, step 471 enables the user to transfer to the multimedia mode from said routing output/display. Thus, any route output or display can be combined with subsequent multimedia, typically in order for the user to gather more information about an emerging travel plan and the places on his or her itinerary. Consistent with the objective of facilitating flexible sequences and combinations of routing and multimedia operations, the user can eventually return from playing multimedia selections after such a transfer from step 453 through step 471 in order to work on further routing operations, returning via path 403, step 465 or step 467. Transfers through step 471 entail transformation of routing data into a multimedia format, as detailed in relation to FIGS. 5, 6A and 6B.

Detailed Description Paragraph Right (197):
The IRMIS invention preferably manages more geographically extensive and data-processing intensive multimedia and/or routing operations on more powerful, desktop, home-base or central dispatch IRMIS computers. Portable IRMIS PDA and PDA/GPS devices are put to work in remote locations with one or more selected, simplified and compacted IRMIS datasets preferably made on the IRMIS desktop. The IRMIS PDA and PDA/GPS devices can be used in the field to log travel paths, mark locations, annotate maps, or enter graphic or text information on geographic points or POIs, as well as for location information and route guidance. The route, point and/or map information so gathered on IRMIS portable devices in the field can be transferred into the home-base or central dispatch IRMIS desktop, then further processed as just described relative to FIG. 4. The transformation and transfer of point, route and/or point information between IRMIS desktop, home-base or service bureau platforms and said portable IRMIS PDA or PDA/GPS devices are further described in other parts of this disclosure, particularly relative to IRMIS FIGS. 2A-2B and 5D-5F.

Detailed Description Paragraph Right (198):
FIG. 5 illustrates cartographic data structures as seen on typical map/route display output in 501 in the upper left drawing. Underlying cartographic data arrangements, typically not seen by the user are shown at 526 (upper right), 551 (lower left) and 576 (lower right) of FIGS. 5A, 5B, and 5C. They are used in alternative embodiments of the present invention to interrelate nodes or routes with POIs found in one or more user-defined regions around an ordinal series of entered waypoints or along a previously computed route. FIGS. 5, 5A, 5B, and 5C help to explain how the present invention enables the user to transfer from substantial routing operations over into the multimedia mode to experience multimedia presentations about POIs or points of interest located within a certain distance of a previously computed route or input waypoint list. These figures reveal general geographical data formats whereby prior route output or substantial waypoint input is transformed into a list of POIs, situated around or along the previous routing output or waypoint list. Data transformations in this manner are done in anticipation of the user selectively playing multimedia information concerning the POIs on the resulting POI list.

Detailed Description Paragraph Right (200):
FIG. 5 comprises one illustration of a map display at 501 as presented on screen to

the user in almost all embodiments and typical utilizations of IRMIS. 501 is a simplified version of a typical electronic map with a computed route displayed by graphic accentuation, as illustrated in FIG. 1G. While such a map display might not be presented to users in some applications or episodes of use e.g. audio output only embodiments or full screen presentations of graphic images or alphanumeric documents about locations, multimedia and routing functions generally are accomplished by means of the cartographic and geographical information structures illustrated as typically displayed to the user at 501.

Detailed Description Paragraph Right (202):
More specifically, 501 in the upper left of FIG. 5 shows a simplified map display. Such map displays appear on the computer screen serving as a graphic interface in practically all modes of operation and various embodiments of the present invention. The map display in 501 is centered upon a location named PLACE, for purposes of this illustration, situated in between SOUTH PLACE and NORTH PLACE, representing municipalities or parts thereof. As is routine in conventional map making and digital cartography, these entities are represented on maps by their names written on the map with the place name situated on the map in relation to its actual geographic location. Sometimes, place name labels on maps are visually associated with a located symbol, such as a dot or political subdivision boundaries or colored area on the map. No such graphic symbols are associated with the underlined place names in the 501 illustration, however, in the interest of a simpler drawing. Generally, place names comprise a particular cartographic data type. In the underlying geographic information system or database, specific geographic coordinates are linked to each place name. Storage, retrieval, manipulation and linkage of place names are done by means of well known list based, spatial, relational, and other database methodologies which are routinely used for management of geographic point types of data.

Detailed Description Paragraph Right (203):
The present invention further employs such routine database methodologies in order to manage another geographic point type of data namely, the POI or point of interest. POIs appear on the 501 map display as boxed labels e.g. THING at 505. Each POI is placed upon the map display in relation to a certain latitude and longitude, or other set of geographic coordinates, related to a specific location on or near the surface of the earth. CAMP, EAT, POLICE and FUN also comprise POI names or labels upon the 501 map display. In consumer travel planning embodiments of the present invention, POIs typically represent accommodations and recreational attractions. For example, the July 1994 release of MAP`N`GO (TM) by DeLorme Mapping Company, Freeport Me. 04032, included the following predefined types or subtypes of POIs represented on the map display by various colored symbols: (1) Points of Interest, i.e., tourist, recreational and cultural attractions essentially symbolized by red arrows; (2) Hotels also, motels, inns, etc. symbolized by yellow diamonds; (3) Campgrounds symbolized by green triangles; and (4) Restaurants by blue circle symbols. Such symbols indicating the availability of multimedia information on certain types of POIs are illustrated at 157 in FIG. 1M, for example. For purposes of a simplified drawing, in FIG. 5, no such POI symbols appear on the map display shown at 501. On the 501 map display, EAT represents a Restaurant POI; FUN is a particular example of a Point of Interest type of POI; CAMP is a certain Campground POI; and HOTEL exemplifies a Hotel type or subtype of POI.

Detailed Description Paragraph Right (204):
But, POIs are not confined to tourist attractions and travel accommodations. Alternative embodiments of the present invention handle a great variety of public facilities or infrastructures as geographic point type POI data e.g. POLICE as shown on the 501 map display. Located or locatable objects in geographical space can also qualify as POIs e.g. THING at 505 on the map display shown at 501. THING might comprise a fixed landmark of human or natural origin. THING might also comprise a moveable object such as a vehicle, another item of personal property, a migratory animal or species, a person on foot, or other non-stationary phenomena as currently known, estimated, or predicted to be at a particular location. POIs can also include intended locations such as the proposed location of a building, a place to meet, or the site of a planned event. The term POI or point of interest lower case encompasses extensive types of geographical point data identified with or related to located or locatable objects which can be input, described, depicted and accounted for in a multimedia database.

Detailed Description Paragraph Right (205):
At 510, 512 and 514 in FIG. 5, waypoints comprise a third major type of geographic point data, in addition to place names and POIs. Waypoints is a term utilized in this disclosure for the starting place, ultimate destination and intermediate locations to stop or pass through on an intended trip. Such a waypoint list is a user selection and ordinal arrangement of the routable nodes or geographic point components of the transportation routes or modes of travel subject to routing computations in a given embodiment. To plan automobile travel on national highways and state roads, waypoints are typically defined in terms of road intersections or turning points in line segments or vector data representing routes customarily traveled by ordinary automobiles. For example, waypoints are defined in terms of road intersections and joints between the straight line segments used to represent normal automobile roads and highways in the routing and multimedia software travel planning utility included with the MAP`N`GO (tm) digital atlas of North America on CD-ROM, released by DeLorme Mapping, Freeport Me., 04032 in July 1994. Any place name is linked for purposes of system functions to the nearest node, i.e., road intersection or other juncture between line segments representing roads.

Detailed Description Paragraph Right (206):
For various alternate embodiments, in order to address marine, air flights, off-road, pedestrian or other forms of transport and travel, waypoints are structured according to the physical and mappable characteristics of those other ways of going places. For example, travel by air involves available airports, private planes and commercial lines, safe and customary flight paths, terrain obstacles, etc., which become factors or building blocks for appropriate air waypoint data structures. Travel on foot is also constrained by legal and safety issues exemplified by sidewalks and crosswalks as well as issues of customary paths or trails and natural terrain limitations plus artificial obstacles, etc. Subways, buses and other public ground transportation systems and public or private marine travel also require waypoint data structures appropriate to the mode of transportation, taking into account factors such as available stops, stations, terminals or docks, regular routes, connections and schedules, human or natural obstacles, safe navigation practices, etc. Ordinary CARS and railroad travel are plainly confined to certain routes and tracks. Travel by air, foot and boat takes place in a more open spatial context still constrained, however, by customary or legal paths or channels and physical obstacles. In the FIG. 5 map display at 501, waypoints 510, 512 and 514 are structured as nodes coinciding with various intersections of ordinary automobile roads and highways.

Detailed Description Paragraph Right (207):
In the 501 map display illustration of FIG. 5, nodes 510, 512 and 514 have been entered in that order as waypoints for a planned trip from SOUTH PLACE, through PLACE to NORTH PLACE. The resulting optimal route computation is being displayed or output by graphical accentuation or highlighting of the recommended route as shown by the fine dotted lines around the optimal route 503 on the 501 map display. This highlighted route is identical with the two-part line segment, representing the route, illustrated at 528, 553 and 578 in the 526, 551 and 576 drawings of FIGS. 5A, 5B, and 5C.

Detailed Description Paragraph Right (208):
The 501 map display illustration further discloses a typical latitude/longitude grid system of horizontal latitude lines e.g. 507 and vertical longitude lines e.g. 508 visibly superimposed as a locational aid over the map display. Such grid systems also are composed in terms of alternate geographic coordinate systems, such as UTM, State Plane as well as proprietary or arbitrary grid systems used for particular map publications. Capital letters in conjunction with roman numerals that run across the top of the map display form a typical system for identifying or naming individual grids, as a visual user aid for a variety of common map interpretation, cross-referencing and indexing chores. For example, the POLICE POI is found in the C-IV grid.

Detailed Description Paragraph Right (209):
Such grid systems may comprise more than just a visual user aid. The present invention is typically, though not necessarily, implemented in conjunction with a geographic information system, or GIS, which manages spatial data with reference to interrelated matrices of quadrangular grids or tiles constructed substantially parallel to lines of

latitude or longitude. Map database systems of this kind are detailed and disclosed, for example, in the David M. DeLorme U.S. Pat. Nos. 4,972,319 and 5,030,117. Also, in U.S. Pat. No. 5,848,373. David M. DeLorme and Keith Gray inventors, titled COMPUTER AIDED MAP LOCATION SYSTEM.

Detailed Description Paragraph Right (210):
Map database systems or GIS organizing geographic data in terms of tiles, quads, grids or frames present several advantages disclosed in the background art just cited. These advantages generally derive from breaking down the massive amounts of data typically involved in a state of the art GIS into discrete, identifiable, adjacent and related map tiles, quads, grids and frames to store, retrieve, manipulate and integrate geographic information. Rapid generation or redrawing of map displays, recentering or panning across seamless maps, zooming to closer or more outlying map scales, as well as the correlation of located data and the management of cartographic computations are all enhanced by such GIS which manage masses of geographic data in small quadrangular units.

Detailed Description Paragraph Right (211):
Such mapping database systems do not necessarily display the underlying system of map tiles, quads, grids or frames which are used behind the screen by the software. For example, the user can typically turn grid displays or longitude/latitude lines off or on, off to de-clutter the display, or on for better map location and orientation.

Detailed Description Paragraph Right (212):
In FIGS. 5A, 5B, and 5C, the drawings at 526, 551 and 576 illustrate three different cartographic data structures, used behind the screen, for the transformation from routing output or lists of waypoints into POI lists which function as input for subsequent multimedia operations. The 526, 551 and 576 drawings illustrate alternative methodologies, used in conjunction with the present invention, to capture POIs situated within some specified distance along or around previous routing output or waypoints listed in order of intended travel. The preferred embodiments of the system manage transformations from routing to multimedia data structures utilizing GIS or map databases that organize geographic data into tiles, grids, quads or frames. Illustrations 526, 551 and 576 each reveal the same behind the screen or underlying system of grids or tiles for efficient geographic databasing. To simplify these drawings, FIGS. 5A, 5B, and 5C show a behind the screen database system of map quads or frames which correspond exactly with longitude/latitude lines and the grid or tile naming system superimposed as a visual aid on the 501 map display of FIG. 5.

Detailed Description Paragraph Right (213):
FIGS. 5A, 5B, and 5C also show POI data corresponding to the 501 map display. For example, the FUN POI in grid C-I upon the 501 map display appears circled as P-F in grid C-I in 526, 551 and 576. Similarly, THING at 505 corresponds to P-T at 536, 559 and 586. Other geographic point data are reproduced exactly from the visible 501 map display over into the underlying behind the screen data representation in 526, 551 and 576. Thus, starting point node 510 in SOUTH PLACE is the same as 534, 557 and 584 in the other three data representations. Elements 512, 530, 555 and 580 all represent the same mid-journey waypoint near PLACE. Likewise the end of the trip is shown at 514, 532, 556 and 582. Moreover, the two-part line segment, which is the highlighted route from SOUTH PLACE through PLACE to NORTH PLACE at 503, is reproduced exactly at 528, 553 and 578.

Detailed Description Paragraph Right (221):
This more complex algorithm is a preferable methodology for applications where a more refined model of accessibility to POIs beside a planned route is desired. Complex multimedia/routing operations are preferably done on more powerful IRMIS desktop or central server computers, which are capable of accessing and quickly processing larger amounts of geographically related information. The IRMIS invention further provides that one or more compact, localized and non-redundant dataset(s) can be selected and "cut" or refined from map, point and/or route information travel plan output as prepared on the larger IRMIS home-base desktop computers. FIGS. 5D, 5E and 5F illustrate the process by which such IRMIS datasets or information packages are prepared for transfer into and portable use upon IRMIS PDA or PDA/GPS devices.

Detailed Description Paragraph Right (222):

By means well-known in the cartographic software field, map and related information subsets can be cut or extracted out of a GIS, or geographical information system database, for example, a map of an area around a point described by geographic coordinates or information associated with a particular lat/long. FIG. 5D further illustrates a state-of-the-art approach to cutting a set of map data around a starting point A and destination B along a route between. FIG. 5E depicts another approach to cutting or extracting a package of map tiles or quads along a route between C and D.

Detailed Description Paragraph Right (223):
The IRMIS invention utilizes an improved approach to cutting or extracting useful, flexible, compact packages of point, route, and/or map information for use in portable PDA handheld devices, with limited memory. As illustrated in FIG. 5F, the user takes advantage of the IRMIS invention to compute and enhance a travel plan from point E (e.g. Boston Mass.) to point F (e.g. Portland Me.). When instructed to make a PDA package or dataset, the inventive IRMIS program first assembles a lower magnitude or greater scale map with less detail encompassing E and F., shown in FIG. 5F as II. Next the IRMIS invention captures at least one lower scale, or higher magnitude map, providing more detail and a closer view, around points E and F. Preferably, such detail maps around the start and finish points are on the order of four (4) magnitudes of resolution greater than the overview map, providing a closer view and more information per square mile. Alternatively, the IRMIS invention can also assemble one or more even closer scale maps of the cities at each end of the planned route. The two or more added levels of closer view and/or greater detail maps are represented by the double-dotted line and solid dotted line boxes or map tiles around E and F.

Detailed Description Paragraph Right (224):
Recreational and business travelers typically make and pick overlapping travel plans, as shown by the intersection of I and II in FIG. 5F. With F as a destination, users are motivated to plan day-trips, client visits or other excursions from F out to H and/or G in I. IRMIS therefore cuts or extracts added map, point and route information package(s), including differential scales or magnitudes, around H and G to be used in the PDA component at locations remote from the desktop--according to the improved algorithm described in the previous paragraph. F is the primary destination or "hub" city, for which the user typically selects more point information. Scarce memory and processing resources on the PDA are saved by further steps in preparing the multiple travel plan dataset or "package" for the PDA. Duplicate records and information in the overlap between I and II are eliminated--so that the PDA is not burdened with two redundant sets of maps, directions, other route information and point information about city F and its immediate surroundings. Other data compression techniques well-known in the art of PDA programming can further conserve PDA resources. Tags or cross-references are inserted in the I and II "sub-packages" or overlapping datasets, in order to facilitate seamless transitions, map movements, and handling of POI queries in the vicinity of city F.

Detailed Description Paragraph Right (225):
FIGS. 6A through 8E depict routing/multimedia operations which are preferably performed upon IRMIS desktop or home-base platforms with their larger computing power and access to more extensive geographically-related databases. Moreover, the route-related multimedia presentations described relative to FIGS. 6A-8E, while advantageous for travel planning, are not essential operations on the IRMIS desktop in the preparation of travel plan output from which map, route and/or pint information datasets can be cut for use on portable IRMIS PDA or PDA/GPS devices. Portable information packages or datasets, according to the present IRMIS invention, preferably are cut from desktop IRMIS travel plans comprising map, route and/or point information concerning at least one starting pint and one destination on a proposed, computed or actual route of travel. The present IRMIS invention can further comprise information recorded on PDA or PDA/GPS devices at remote locations in the field. For example, users of portable IRMIS PDAs can make annotations about geographic locations and travel routes; and IRMIS PDA/GPS devices facilitate marking locations, tracking or logging "breadcrumbs" or series of points representing actual travel paths, plus date/time/lat-long stamping of user annotations and/or digital photos made in conjunction with the PDA/GPS. Thereafter, such information gathered on one or more portable IRMIS devices can be transferred into the IRMIS desktop or central dispatch system for further processing or display. For example, such information can be used to update real estate, security service, sales/delivery route, etc. databases; such

information can be used to display a historical record or replay of part or all of an actual trip; and/or such information can be incorporated within the IRMIS desktop GIS database for use in future travel planning or multimedia/routing operations and presentations.

Detailed Description Paragraph Right (229):
As detailed hereafter, further processes explained relative to FIG. 6B loop back through A1. Moreover, in an alternative embodiment, the user can enter A1 at 605 in order to process canned or prepackaged node lists offered as data accessories. A1 at 605 also provides access for the user to recall lists of nodes representative of ordinal waypoint input or routing output from memory or from a database process. Unless processing of a list of nodes for a route between an origin and a destination is complete, step 607 leads to the processing of the next node. After processing of a list of nodes for the route is complete, it passes through 607 and C to the multimedia mode. Steps 608 and 610 get the current node ready for the subsequent search for POIs.

Detailed Description Paragraph Right (236):
The operations illustrated in FIG. 7 commence through E at step 702. The connector E is also shown in FIG. 3, after step 305, which more generally represents the interface engaged by the user to prompt and manage Show/Tell One multimedia information about a single selected POI or location. In the initial release of MAP`N`GO (TM) 1.0 by DeLorme Mapping Company, Freeport, Me., this interface is accessed by pushing a button called Show/Tell One in the Points of Interest system dialog box a.k.a. the POI Listbox illustrated at 148 in FIG. 1J and at 162 in FIG. 1-O. For an example, typically the user points and clicks on one of the POIs as listed in this dialog box and then pushes the Show/Tell One button in order to prompt multimedia about that particular POI. Relative to FIGS. 2 and 3, other methods are detailed for users to locate and pick multimedia POI input.

Detailed Description Paragraph Right (237):
In FIG. 7, operations proceed from step 702 to both steps 704 and 706, which are implemented concurrently. The system defaults to available audio or pictures through steps 704 and 706. Audio output is played at 710, with volume and other variables controlled at 716. As delineated in FIG. 7, for the July 1994 release of MAP`N`GO 1.0 each POI in the database of multimedia is associated with no more than one audio output. This is typically a short travelog narration with background music. Likewise, no more than one picture is associated with any given POI typically a digital photo of a museum, a unique natural site, an hotel or a restaurant found at the POI location. Other embodiments of the system include multiple still or moving pictures and additional, selectable audio outputs. Thus, if it is all that is available in a Show/Tell One episode, then a sound recording plays to its end whereupon, the user returns at 725 to the POI Listbox. But, if a picture is available, then step 708 shows it for a preset adjustable period of time. Alternate embodiments of the present invention include multiple audio or visual images related to individual POIs. The user can browse, edit and arrange flexible multimedia presentations about a single POI through routine manipulation of such multiple audio or visual materials.

Detailed Description Paragraph Right (238):
At minimum, in the July 1994 release of MAP`N`GO 1.0 every POI, for which there is information in the database of located multimedia, has one related text message. Typically, such a POI text message literally transcribes the optional audio travelogue narration. Variant embodiments include multiple textual documents linked to individual POIs communicating a broad range of information about the POI location in diverse alphanumerical formats. Examples include comprehensive demographic, historical, or environmental information about locations, commercial or personal data about parties located at residential or business addresses, running inventories or data tabulations pertaining to particular sites, and references to or excerpts from works of fact or fiction citing the location. The first release of the system software does provide detailed text information about rooms, amenities, prices, phone numbers, nearby attractions, etc. for an extensive selection of hotels, campgrounds and other overnight accommodations as illustrated in FIGS. 1L and 1M. As released in July 1994, MAP`N`GO 1.0 provides the Show/Tell One multimedia user access to such text displays as an elective option at 714 in FIG. 7. Alternate embodiments default to text output and extend the user options to focus upon specific topics or textual content by means

of routine state of the art software text search technologies. Audio and visual images are "played" to accompany or substitute for text in alternate embodiments. IRMIS displays such text at the user's option 714 in step 712.

Detailed Description Paragraph Right (239):
In FIG. 7, steps 718 and 720 illustrate user options and controls which enhance flexibility and selectivity of play in the multimedia mode. Dotted line boxes and connecting lines, as in 718 and 720 and between 708 and 718, represent user commands, options, and controls made available throughout a series of steps. Thus, for example, step 718 options are available all during any sound 710 or picture 708 show and any text 712 display as well as any combinations thereof. As shown at 748, 749 and 750, the slide control options at step 718 are essentially buttons of the familiar rewind, stop and fast forward types which let the user replay, halt or advance any presentation in any medium. More detail is provided on these slide control options relative to FIG. 8D.

Detailed Description Paragraph Right (240):
IRMIS displays pictures or optional text for a preset, adjustable time period. Steps 723 and 727 measure whether this time period has expired and maintain the display of pictures or text until expiration of said time period. Step 720 extends this time period whenever the user elects to call up a dialog box in order to change display settings on the fly or otherwise adjust format or output options for ongoing multimedia. Consistent with overall invention objectives, these features let the user browse or sample multimedia information about a certain location with flexibility to dwell upon or review information of particular interest, or fast-forward through less interesting parts of a presentation. Moreover, a presentation gets extended or prolonged while the user is adjusting the presentation format or proceeding to attach selected POI information to his or her travel plan, or to select or deselect a POI as a waypoint, for purposes of subsequent routing operations. These flexibility features not only enhance the user playing the multimedia in the first instance. Selectivity in the multimedia mode further enables the user to focus upon particular multimedia in order to pick POI locations for transformation into waypoints, or to edit pictorial, text or audio travel information for attachment to travel plans.

Detailed Description Paragraph Right (241):
Steps 729 and 731 remove or end display of pictures or text when the preset time period for display has expired. In the Show/Tell One module, steps 737 and 735 return the user to the POI Listbox, i.e., to connector C in FIG. 3. The user is also returned to the POI Listbox or main multimedia menu at the end of available recorded audio, or if the user employs the 718 slide control in order to stop an ongoing multimedia presentation on a single POI, at step 725. Step 739 presents a modal dialog box routine, in effect, asking the user "Are you done?" whenever a text and picture presentation are complete. At this point, the user can opt to select or delete the pertinent POI or the nearest node as a waypoint or to edit and/or attach multimedia information about the POI to an emerging travel plan. The user hits an OK button in step 741 in order to return through step 743 to step 708 where the picture display clock is restarted. Unless the user opts for a replay of the text option at 714, steps 723, 729 and 735 time out the picture and return the user to the POI list box as shown in FIG. 3 and FIG. 1J at 148.

Detailed Description Paragraph Right (242):
As released in July 1994, MAP`N`GO 1.0 enables the user to choose between Show/Tell One, as detailed relative to FIG. 7, and Show/Tell All, as detailed relative to FIGS. 8A-8E. Alternate embodiments facilitate filtering a short list of POIs from a larger list of POIs, according to a wide range of criteria and methodologies available in the art of computerized management of lists. In other words, given an array of 50 or 500 POIs found along a route or from a coarse multimedia database search or from a canned or prepackaged list of POIs, alternative embodiments of the present invention facilitate automated sorting of the long list by obvious state of the art software techniques. The user can then concentrate the subsequent multimedia presentations on POIs of particular interest with specific characteristics. Users of alternative embodiments can distill, condense and refine long POI lists for more efficient multimedia presentation, using well known obvious technologies.

Detailed Description Paragraph Right (244):

FIG. 7 presumes the underlying map display encompasses or is centered upon the single pertinent POI. But, shown generally at step 307 in FIG. 3 and detailed in FIGS. 8B and 8C the Show/Tell All command prompts multimedia presentations about each item on an entire list of POIs. Depending on map scale and the distance between POIs, not all POIs on a given list necessarily appear on the map display serving as background and cartographic interface on the computer screen for practically all embodiments and uses of the present invention. FIG. 8A illustrates the process that automatically shifts or pans the map display, as required, to center upon the geographic coordinates of the POI currently the focal point of a Show/Tell All multimedia presentation.

Detailed Description Paragraph Right (245):
The processes shown in FIG. 8A commence at connector F as also shown following step 307 in FIG. 3. Step 307 corresponds to step 800 in FIG. 8A. Step 800 presumes a current POI list of two or more POIs. Step 801 initializes the process depicted in FIG. 8A, setting a pointer on the first POI on the current list. This pointer is incremented in various contexts revealed in FIGS. 8B and 8C hereafter. In IRMIS embodiment, step 803 in FIG. 8A facilitates Show/Tell All operations looping back up and reentering at F1 for a new cycle of map centering operations each time the Show/Tell All module is ready to focus on the next POI on the current list. Step 803 serves further as entry point for series of multimedia presentations that commence at some user-selected point along a previously computed route or part way down a POI list in alternate embodiments of the present invention.

Detailed Description Paragraph Right (246):
Step 804 fetches the next POI on the current list, i.e., the next POI which is about to become the focus or locus of a multimedia information presentation done in the Show/Tell All module. If the map display is not already centered upon or does not cover this next POI as determined in step 806, then at 808 the map display shifts or pans to re-center approximately on the geographic coordinates of said POI. For example, consider a POI list consisting of two items, namely offices located in Los Angeles and New York City. Assuming that Los Angeles is first on the list, step 808 redraws the map display to center on the New York City office just as the multimedia about the New York office is about to begin and right after multimedia about the Los Angeles site is completed or terminated by the user.

Detailed Description Paragraph Right (247):
Even when the map display easily encompasses successive POIs on a given list, so there is no need to shift or re-center the map display, IRMIS indicates the current POI utilizing a characteristic graphic Locator Arrow on screen. Step 810 takes care of drawing such an arrow to the next or newly current POI. Step 810 further removes the Locator Arrow that pointed to the preceding or old POI.

Detailed Description Paragraph Right (250):
From F2, the operations illustrated in FIGS. 8B and 8C proceed to steps 813 and 814 which are implemented concurrently. Although alternate embodiments of the invention might default to a text display of information about the current POI, the Show/Tell All command of the system prefers available sound or audio output and pictures or visual/graphic images. Available sounds, such as travelog narrations, are played at 818 from beginning to end subject to user control of audio volume, tone, etc. in step 825. In alternate embodiments, audio output calls for user interaction or responses. The audio output pauses and waits for an appropriate user response, proceeding apace if the user does not answer for a predetermined interval. IRMIS displays available pictures for a preset, adjustable time in step 816.

Detailed Description Paragraph Right (251):
The MAP`N`GO (TM) July 1994 release automatically displays literal non-vocalized text as words printed typically in a window over the map display on screen only in the event that no sound or pictures are available relating to the current POI location. The interplay between steps 813, 814 and 821 demonstrate this logic. However, step 823 enables the user to opt for display of silent alphanumeric text information on screen, supplementing available pictures. This feature addresses the practical reality that, while audio-visual output is preferred for many consumer travel information embodiments, many users and installed systems lack sound cards and speakers. Moreover, though audio output is preferred as a rule for drivers alone who must keep their eyes on the road and instrument panel, under some circumstances, in vehicle users opt for

having a passenger monitor literal text and pictures in windows on the map display, electing to turn the sound off to facilitate conversation or for enjoyment of silence or listening to music tapes or news on the car radio for example.

Detailed Description Paragraph Right (253):
Moreover, as depicted in FIGS. 7, 8B, and 8C within a multimedia presentation concerning a particular POI, the system embodiment enables the user to select, review and segregate portions of the available multimedia information with regard to both media and content. Thus, the user can concentrate on the available informational content that is of the most immediate interest, using the medium or media most convenient or useful under the circumstances. Otherwise stated, this capability for user-controlled, flexible and focused play of multimedia information about specified locations facilitates individualized, interactive user responses. For example, users can make individual choices about what POIs to add to, or remove from, their list of waypoints along a planned itinerary based on their own selection among available multimedia information about those POI locations. The first release of MAP`N`GO 1.0 further facilitates selective attachment of text information about POIs, picked by the user, to travel plan output generated by combined or sequenced routing and multimedia processes.

Detailed Description Paragraph Right (255):
The present IRMIS invention further comprises information recorded on PDA or PDA/GPS devices at remote locations in the field. For example, users of portable IRMIS PDAs can make annotations about geographic locations and travel routes, and IRMIS PDA/GPS devices facilitate marking locations, tracking or logging "breadcrumbs" or series of points representing actual travel paths, plus date/time/lat-long stamping of user annotations and/or digital photos made in conjunction with the PDA/GPS. Thereafter, such information gathered on one or more portable IRMIS devices can be transferred into the IRMIS desktop or central dispatch system for further processing and display. For example, such information can be used to update real estate, security service, sales/delivery route, etc., databases; such information can be used to display a historical record or replay of part or all of an actual trip, and/or such information can be incorporated within the IRMIS desktop GIS database for use in future travel planning or multimedia/routing operations and presentations.

Detailed Description Paragraph Right (257):
According to the present IRMIS invention, the CD-ROM data-updating or Replace functions are further supplemented and improved upon by automated data coordination between the desktop or central dispatch IRMIS home-base platform and the datasets or information transferred into and/or recorded on one or more portable IRMIS PDA or PDA/GPS devices. As detailed relative to FIG. 2B in this disclosure, this data coordination or integration between IRMIS home-base and IRMIS portable(s) comprises optional, controllable one-way or two-way synchronization of selected component databases, e.g., maps, text directions, address books, route depictions, POI or point information, digital photo data, and so forth. Thus, information recorded on portable IRMIS devices at remote locations can be automatically incorporated into corresponding databases on the IRMIS desktop or central dispatch computer; also, at the user's option, upon "docking" with the IRMIS "mothership" or desktop, portable IRMIS devices can be automatically updated and reset in preparation for further use.

Detailed Description Paragraph Right (259):
While step 818 plays prerecorded audio to its conclusion, steps 816 and 829 work together to display available pictures for a preset, user adjustable period of time. Any text information displays are similarly clocked by means of steps 821 and 835. Unless the user intervenes, located information is heard for its duration, read and seen for a period of time. Once such information plays are over without the user taking action, Show/Tell All proceeds to present multimedia on the next POI. Available at any point in any Show/Tell All output operation, step 819,866 provides the user with slide controls of the rewind, stop and fast-forward type, revealed in more detail in FIG. 8D. Step 819,866 lets users discretely replay, extend or advance audio, visual and text outputs together or as individual media. The user can concentrate on, repeat or skip over particular information at will, electing a certain medium or combination of media as well.

Detailed Description Paragraph Right (260):

This capability aids the user to interact with or respond to the multimedia information, for example: (1) to make decisions about which POIs or locations to include or delete as waypoint inputs; or (2) to pick, edit and compose location-related information for attachment to combined travel plan output. Likewise, step 827 stops the clock or blocks expiration of text information outputs or displays whenever the user opts to engage in manipulation or adjustment of the multimedia output/display. This means that the map display and related text information window remain in place focusing on the current POI while the user engages in activities such as resetting the time period for text or visual displays, or resizing or repositioning text or picture windows covering part or all of the map display, or modification of waypoint lists or the attachment of information to travel plans.

Detailed Description Paragraph Right (261):
In FIGS. 8B and 8C steps 831 and 833, 837 and 839, 851 and 853 do essentially the same job for audio, text and visual presentations. These steps increment the POI pointer to the next POI left on the current POI list once a specific presentation is finished or terminated by the user. The user then returns to F1 in FIG. 8A to get the next POI, and re-center the map display if needed.

Detailed Description Paragraph Right (262):
Presentations about the final POI on the current list are complete as determined in steps 831, 853 and 839 respectively for audio, text and pictures. Then the locator arrows for current POIs, see step 810, and other symbols or legends placed on the map display as part of any multimedia presentation, are erased or cleaned up in steps 841, 855 and 846. Then, steps 849, 848 and 863 return the user to the POI Listbox or main multimedia menu, as detailed relative to FIG. 3.

Detailed Description Paragraph Right (263):
In the manner of a modal dialog box, at the end of a text and picture display, step 857 holds text and pictures on screen while asking the user "Are you done?" in effect. The user then can opt to select or delete the pertinent POI or the nearest node as a waypoint, or to edit and attach multimedia information about the POI to an emerging travel plan. Or if the user hits the 859 OK button, then the text display is removed in step 861, and the process returns to restart the picture display clock at step 816. Unless the user opts for a replay of the text option at 823, steps 829 times out the picture. If there still are more POIs on a Show/Tell All list, steps 839 and 837 return the user to connector F1 in FIG. 8A to get the next POI on the current list. At the end of the current POI list, as detected in step 839, step 846 cleans up the map display. At 848, operations are returned to the POI listbox that is detailed further relative to FIG. 3 and FIG. 1J at 148.

Detailed Description Paragraph Right (264):
FIG. 8D details the working of the "stop", "rewind", and "fast-forward" style Slide Control shown at 718 in FIG. 7 and 819 and 866 in FIG. 8. At connector F3, the user is presented on the system interface with optional buttons to replay, halt or advance multimedia presentations. At 874 and 878, the forward and back arrow buttons effectively increment or decrement the POI pointer. Steps 880 and 882 reset the presentation on the beginning of the current list whenever the user backs up past the first item on a given POI list. Thus, full back and forward operations move the user to F2, which is the beginning of Show/Tell operations shown also in FIG. 8B. The Stop button brings multimedia operations to a halt at 872, cleaning up any text or pictures presented in windows on top of the map display in 876. The Stop button takes the user back to the POI listbox which is the startup multimedia mode described in relation to FIG. 3.

Detailed Description Paragraph Right (265):
FIG. 9 is a block diagram of a modular suite of software controls programmed to modify IRMIS PDA map display and output variables, in response to IRMIS GPS as processed in conjunction with the user's travel plans.

Detailed Description Paragraph Right (267):
PDA OUTPUT CONTROL 904 is also impacted at least by user commands and pre-set preferences 909 as well as memory 911 and available data. For example, one IRMIS embodiment, SOLUS.TM. Pro implemented on 3COM.TM. Palm.TM. Computing platforms, automatically "zooms" shifting to greater detail, closer view maps or higher magnitude

maps when such mapping information is to be found in the PDA memory for the PDA user's current geographic position indicated by the GPS. Thus, the OUTPUT CONTROL 904 software is programmed to query both the PDA memory for available maps at a closer scale and the GPS for current position information. The user can override this default shift in map scales by inputting his/her preferences at 909.

Detailed Description Paragraph Right (268):
Another FIG. 9 scenario was described in the parent patent application "COMPUTING AIDED MAP LOCATION SYSTEM" (or CAMLS) Ser. No. 08/265,327 filed Jun. 24, 1994, and also assigned to DeLorme Publishing Co. Inc., now U.S. Pat. No. 5,848,373. CAMLS describes alternative or toggled map displays--ROAD EYES AND EARS and LOOK ABOUT. ROAD EYES AND EARS focuses on critical driving information along the road ahead of the user's current position--for example, speed, time to next turn, specific directions for next turn, and so on as provided on the IRMIS "Navigate" screen shown in FIG. 1A4b. The FIG. 9 OUTPUT CONTROL prompts ROAD EYES AND EARS variously as a function of time/distance to next turn and/or speed. A beep warns the driver one minute before the next turn. The map screen shifts to "Navigate" or alternatively the "Navigate" screen shows for 10 seconds then the corresponding map screen is displayed for 10 seconds. CAMLS details such sequenced displays.

Detailed Description Paragraph Right (269):
As described in CAMLS, LOOK ABOUT is a map screen mode which focuses on more detailed information about points of interest, or attractions and facilities, around the user's current geographic position as detected by the GPS. LOOK ABOUT provides restaurant menus, describes motels, parks, museums, and other accommodations found within a radius of distance or travel time around a point. The FIG. 9 OUTPUT CONTROL implements LOOK ABOUT, for example, as a function of the GPS detecting that the user has slowed down below a preset speed and/or has stopped completely for a pre-set span of time. In other words, when driving instructions are not critical, and when the user is more likely to be interested in his/her surroundings, LOOK ABOUT de-emphasizes "Directions" and "Navigate" screens, and displays more detailed map screens and/or information about points of interest surrounding the PDA user's current location. Alternatively, while the user's vehicle is en route, even when approaching a next turn, the passenger who does not have to watch the road can manually prompt LOOK ABOUT at 909 in FIG. 9 to get added information about local attractions and facilities.

Detailed Description Paragraph Right (270):
As shown at 913 in FIG. 9, the IRMIS invention also works to facilitate GPS controls for alternate devices, like a digital camera, connected to the user PDA/GPS, as illustrated in FIGS. 1A3 and 1A5(C) heretofore. For example, the digital camera might be programmed to take pictures at specified intervals of time and/or distance traveled--or at or near a specified position or set of geographic coordinates, proximity to which location is detectable by the GPS linked to the PDA.

Detailed Description Paragraph Left (10):
Safety Warning: Bring a passenger along to serve as GPS operator while you are driving a vehicle. Solus Pro should not be used in automatic navigation or guidance systems or for any purpose requiring precision measurement of distance or direction. See GPS Position Accuracy for additional information.

Detailed Description Paragraph Left (11):
Viewing Maps in Your Palm Computing Organizer

Detailed Description Paragraph Left (12):
To View Your Map

Detailed Description Paragraph Left (13):
Safety Warning: Bring a passenger along to serve as GPS operator while you are driving a vehicle. Solus Pro should not be used in automatic navigation or guidance systems or for any purpose requiring precision measurement of distance or direction. See GPS Position Accuracy for additional information.

Detailed Description Paragraph Left (15):
Initializing DeLorme's GPS Receiver with a Palm Computing Organizer

Detailed Description Paragraph Left (16):
Safety Warning: Bring a passenger along to serve as GPS operator while you are driving a vehicle. Solus Pro should not be used in automatic navigation or guidance systems or for any purpose requiring precision measurement of distance or direction. See GPS Position Accuracy for additional information.

Detailed Description Paragraph Left (18):
Safety Warning: Bring a passenger along to serve as GPS operator while you are driving a vehicle. Solus Pro should not be used in automatic navigation or guidance systems or for any purpose requiring precision measurement of distance or direction. See GPS Position Accuracy for additional information.

Detailed Description Paragraph Left (28):
Safety Warning: Bring a passenger along to serve as GPS operator while you are driving a vehicle. Solus Pro should not be used in automatic navigation or guidance systems or for any purpose requiring precision measurement of distance or direction. See GPS Position Accuracy for additional information.

Detailed Description Paragraph Left (29):
Viewing Maps in a Windows CE Device

Detailed Description Paragraph Left (30):
To View a Map

Detailed Description Paragraph Left (31):
There are two types of maps that you can send from Topo USA--map views and route maps.

Detailed Description Paragraph Left (32):
Initializing DeLorme's GPS Receiver with a Windows.RTM. CE Device

Detailed Description Paragraph Left (33):
Safety Warning: Bring a passenger along to serve as GPS operator while you are driving a vehicle. Solus Pro should not be used in automatic navigation or guidance systems or for any purpose requiring precision measurement of distance or direction. See GPS Position Accuracy for additional information.

Detailed Description Paragraph Left (35):
Safety Warning: Bring a passenger along to serve as GPS operator while you are driving a vehicle. Solus Pro should not be used in automatic navigation or guidance systems or for any purpose requiring precision measurement of distance or direction. See GPS Position Accuracy for additional information.

Detailed Description Paragraph Left (36):
Monitoring Your GPS Status in a Windows CE Device

Detailed Description Paragraph Left (38):
Monitoring Your GPS Position in a Windows CE Device

Detailed Description Paragraph Left (48):
When in any mode other than the map mode, you can access the map by pressing ALT+M.

Detailed Description Paragraph Type 0 (1):
Average Speed--when tracking, displays your average speed

Detailed Description Paragraph Type 0 (2):
Battery Voltage--displays the current voltage of your organizer's batteries

Detailed Description Paragraph Type 0 (3):
Bearing--when tracking, displays the direction of travel between your next waypoint and your current position, relative to true North

Detailed Description Paragraph Type 0 (4):
Course--when tracking, displays the direction of travel between your next waypoint and the previous waypoint, relative to true North

Detailed Description Paragraph Type 0 (5):
Date--when connected to DeLorme's GPS receiver, displays the current date

Detailed Description Paragraph Type 0 (6):
Dist to Finish--when tracking, displays the distance from your current position to your Finish

Detailed Description Paragraph Type 0 (7):
Dist to Next Turn--when tracking, displays the distance from your current position to your next turn or route change Elevation--when tracking, displays your current elevation (Due to Selective Availability, this can vary as much as 512 feet (156 meters); however, 95 percent of the time you can generally expect much greater accuracy.)

Detailed Description Paragraph Type 0 (8):
Heading--when tracking, displays your current direction of travel, relative to true North

Detailed Description Paragraph Type 0 (9):
Maximum Speed--when tracking, displays your maximum speed

Detailed Description Paragraph Type 0 (10):
PDOP--when tracking, displays the Position Dilution of Precision, the effect of the combined errors of latitude, longitude and elevation in determining a position

Detailed Description Paragraph Type 0 (11):
Speed--when tracking, displays your speed as you travel

Detailed Description Paragraph Type 0 (12):
Time--when connected to DeLorme's GPS receiver, displays the Greenwich Mean Time

Detailed Description Paragraph Type 0 (13):
Time to Finish--when tracking, displays the time from your current position to your Finish

Detailed Description Paragraph Type 0 (14):
Time to Next Turn--when tracking, displays the time from your current position to your next turn or route change

Detailed Description Paragraph Type 0 (15):
Tripometer--when tracking, displays the mileage traveled (Select Tools . . . Preferences . . . Reset Tripometer to reset the value to zero.)

Detailed Description Paragraph Type 0 (16):
ALT+PG UP Zooms out from the map

Detailed Description Paragraph Type 0 (17):
ALT+PG DN Zooms In on the map

Detailed Description Paragraph Type 0 (18):
K key When tracking, adds a Mark at the map center

Detailed Description Paragraph Type 0 (19):
X key When tracking, recanters the map on your current position

Detailed Description Paragraph Type 1 (13):
6. The Directions mode displays the Route Directions that you created in Topo USA.

Detailed Description Paragraph Type 1 (17):
4. Tap the Tools menu and then tap the Select Map option.

Detailed Description Paragraph Type 1 (18):
5. Tap the desired map to select it and then tap OK

Detailed Description Paragraph Type 1 (19):
6. The Map mode displays the map that you created in Topo USA. Tap the map to pan around.

Detailed Description Paragraph Type 1 (20):
1. Connect your organizer to DeLorme's GPS receiver with DeLorme's Palm Computing adapter cable (available separately from DeLorme).

Detailed Description Paragraph Type 1 (24):
5. Tap the Initialize menu option and initialize your GPS receiver.

Detailed Description Paragraph Type 1 (28):
1. Connect your organizer to DeLorme's GPS receiver with DeLorme's Palm Computing adapter cable (available separately from DeLorme).

Detailed Description Paragraph Type 1 (32):
5. Tap the Initialize menu option and initialize your GPS receiver.

Detailed Description Paragraph Type 1 (42):
1. After you have sent your maps to the H/PC, tap the Solus Pro icon on the desktop to open the program.

Detailed Description Paragraph Type 1 (43):
2. Tap the Map tool and select the desired map. Solus Pro map files have .RI extensions and are saved in the DeLorme folder by default.

Detailed Description Paragraph Type 1 (44):
3. The map appears in the main window.

Detailed Description Paragraph Type 1 (45):
4. The latitude and longitude of the map's center are displayed on the command bar, along with the magnitude of the map.

Detailed Description Paragraph Type 1 (49):
4. As the GPS receiver acquires data from the satellites, information appears in the columns. Each satellite's ID number, elevation, azimuth and sound-to-noise ratio are displayed on the left. The right window displays the GPS receiver's channels, the corresponding satllite ID and the status of the signal. "T" indicates the number of satellites in the receiver's track or view of the sky, "E" indictes the acquisition of ephemeris data and "N" indicates the number of satellites being used by your receiver for navigation.

Detailed Description Paragraph Type 1 (50):
5. The GPS Status box on thee right indicates whether or not you are receiving satellite information. "No Fix" means that the GPS receiver has not been detected or you are not receiving enough information to determine a fix. "Acquiring Satellites" indicates that the GPS receiver is acquiring satellite information, but is not yet receiving sufficient satellite data to determine your position. This message is displayed while the receiver is acquiring satellite data and can take several minutes. "2D Nav" indicates that you are receiving data, but it is not sufficient to determine your elevation. "3-D Nav" indicates that you are receiving ample data and have a good fix.

Detailed Description Paragraph Type 1 (51):
6. Use the slider to change the update rate of the satellite status display.

Detailed Description Paragraph Type 1 (54):
3. Your current latitude/longitude, the time an date, your current heading, the GPS status, and your current speed are displayed.

Detailed Description Paragraph Type 1 (57):
2. Tap the Sky View tool. The sky view diagram indicates the locations of visible satellites in the sky relative to your current position. White symbols show the satellites' positions in the sky.

Detailed Description Paragraph Type 1 (58):
A black symbol indicates that your GPS receiver is tracking the satellite, ephemeris data is available an the satellite is being used for navigation. When using DeLorme's GPS receiver, a gray symbol indictes that your GPS receiver is tracking the satellite and ephemeris data is available, but the satellite is not being used for navigation. Two pound symbols indicate that your GPS receiver is tracking the satellite, but it is not receiving data from it.

Detailed Description Paragraph Type 1 (59):
3. The GPS Status box on the right indicates whether or not you are receiving satellite information. "No Fix" means that the GPS receiver has not been detected or you are not receiving enough information to determine a fix. "Acquiring Satellites" indicates that the GPS receiver is acquiring satellite information, but is not yet receiving sufficient satellite data to determine your position. This message is displayed while the receiver is acquiring satellite data and can take several minutes. "2-D Nav" indicates that you are receiving data, but it is not sufficient to determine your elevation. "3-D Nav" indicates that you are receiving ample data and have a good fix.

Detailed Description Paragraph Type 1 (61):
1. Connect your GPS receiver, open Solus Pro and begin tracking.

Detailed Description Paragraph Type 1 (62):
2. Tap the Map tool and select the desired map.

Detailed Description Paragraph Type 1 (63):
3. When at the desired location, press the K key on your keyboard to place a Mark on the map.

Detailed Description Paragraph Type 2 (2):
Tap the Go To button to find the selected Mark on the map.

Detailed Description Paragraph Type 2 (3):
Tap the Delete button to delete the selected mark from the marks list and the map.

Detailed Description Paragraph Table (1):
To send a route 1. Be sure that the Solus Pro application is installed on both your desktop computer and your handheld computer. 2. Create your route in Topo USA. 3. Click the Send Route button in the Advanced Routing dialog box. 4. The Send Route dialog box appears. 5. Select the desired options (i.e., current map view, route map and Route Directions) and the type of platform. 6. Click the Preferences . . . button to set your preferences for the individual devices. 7. Click OK. 8. Topo USA creates the appropriate files and displays a message box telling you where they were saved. The default location is C:.backslash.DeLorme Mobile Maps. 9. Transfer the files to your handheld computer according to the protocol outlined in its user's guide. 10. When the transfer is complete, open the Solus Pro application on your handheld computer by tapping its icon. NOTE: You can send the current map view without creating a route. Adjust the map view to the desired location and click the Send Route tool. NOTE: If you open a previously saved route to send to a handheld computer, you must be using the appropriate CD for the region containing the route.

Detailed Description Paragraph Table (2):
To initialize DeLorme's GPS receiver: 1 Connect your organizer to DeLorme's GPS receiver with DeLorme's Palm Computing adapter cable (available separately from DeLorme). 2. After you have sent your route to the handheld, turn on your organizer and tap the Applications button on the screen to access the application picker. 3. Tap the Solus icon to open the application. 4. Tap the Menu button. The Solus Pro menus appear at the top of the screen. 5. Tap the Mode menu option and then tap Initialize to access the Initialization mode. 6. Tap the Device drop-down list and use the up and down arrows to select your GPS receiver. 7. Tap the State drop-down list and use the up and down arrows to select your current location. You can also use the organizer's scroll buttons to move through the state list. NOTE: After the first initialization, the State drop-down list defaults to Last (representing your last location or fix). If you are within the same vicinity as your last fixed position, you should use the Last option to speed up the initialization process. If you have a map loaded in Solus, you

can select the Map Center option to use the map's center coordinates to initialize. 8. A stream of data at the bottom indicates that you are receiving satellite information. The symbol in the upper right corner indicates your GPS status. A circle with a line through it means that DeLorme's GPS receiver has not been detected or you are not receiving enough information to determine a fix. The transmitting symbol indicates that DeLorme's GPS receiver is acquiring satellite information, but is not yet receiving sufficient satellite data to determine your position. This message is displayed while DeLorme's GPS receiver is acquiring satellite data and can take several minutes. "2-D" indicates that you are receiving data, but it is not sufficient to determine your elevation. "3-D" indicates that you are receiving ample data and have a good fix. 9. Tap the DST option if daylight saving time is currently in effect where you are. The second line displays the offset for your time zone from the Greenwich Mean Time. 10. A stream of data at the bottom of the screen indicates that you are receiving signals from satellites. 11. When the status is "3-D", tap the OK button to close out of the Initialization mode. 12. Tap the Menu button on your organizer. The Solus Pro menus appear at the top of the screen. 13. Tap the Mode menu option and select which mode (i.e., Directions, Position, Navigate or Map) you want to view. 14. When you want to stop tracking, tap the Stop button in the Position mode (this will help save your organizer's batteries). A solid circle in the upper right corner indicates that you are not tracking. You can tap the Start button in the Position mode to resume tracking. NOTE: In order to conserve batteries, be sure to disconnect the adapter cable when not using DeLorme's GPS receiver with your organizer.

Detailed Description Paragraph Table (3):
To track: 1. Connect your organizer to DeLorme's GPS receiver with DeLorme's Palm Computing adapter cable (available separately from DeLorme). 2. After you have sent your route to the organizer, turn it on and tap the Applications button on the screen to access the application picker. 3. Tap the Solus icon to open the application. 4. Tap the Menu button. The Solus Pro menus appear at the top of the screen. 5. Tap the Mode menu and then tap the Initialize option to initialize DeLorme's GPS receiver 6. If you want to track using your Route Directions, tap the Directions menu option to view the route that you created in Topo USA. As you travel, Solus Pro highlights the next road you will use and beeps 60 seconds before your next route change. The Directions include your Start, the road name and type for each leg of your journey, the cumulative elapsed time and distance after each leg, the general heading for each leg, any Stops you have added, and your Finish. Tap the scrollbar arrows on the right to move up and down through the Directions or use the organizer's scroll buttons. Symbols appear along the left side of the Directions. Solid circles represent your Start, Stops and Finish. A dotted single line indicates a local road or ferry, a solid double line indicates a US highway or interstate, a single solid, thick line indicates a state route or major connector, a single solid, thin line indicates a forest road, and a solid double line with a dollar sign indicates a toll road. Your GPS status is displayed in the upper right corner. A circle with a line through it means that DeLorme's GPS receiver has not been detected or you are not receiving enough information to determine a fix. The transmitting symbol indicates that DeLorme's GPS receiver is acquiring satellite information, but is not yet receiving sufficient satellite data to determine your position. This message is displayed while DeLorme's GPS receiver is acquiring satellite data and can take several minutes. "2-D" indicates that you are receiving data, but it is not sufficient to determine your elevation. "3-D" indicates that you are receiving ample data and have a good fix. 7. You can also track in the Navigate mode. Tap the Navigate menu option to view your current route status. The instructions for your next route change appear at the top of the screen and update as you travel. Use the arrows in the output boxes to select from a variety of options that you can display in the Navigate screen. 8. Tap the Map menu option to view your current position on the map. NOTE: In order to conserve batteries, be sure to disconnect the adapter cable when not using DeLorme's GPS receiver with your organizer.

Detailed Description Paragraph Table (4):
To Initialize: 1. Connect your H/PC to DeLorme's GPS receiver with DeLorme's Windows CE adapter cable (available separately from DeLorme). 2. After you have sent your route to the H/PC, tap the Solus Pro icon on the desktop to open the program. 3. Tap the GPS button and select Initialize . . . to access the Initialize GPS dialog box. 4. Tap the State drop-down list and use the up and down arrows to select your current

location. For the first initialization of your receiver, select the state/province where you are located from the State drop-down list. The latitude and longitude are automatically entered. After your first initialization, the State drop-down list defaults to Last Location and indicates the latitude and longitude of your last fixed position. Unless your position has changed more than a few miles, you should use Last Location in order to decrease the amount of time it takes for your receiver to acquire a fix on your position. If the area in which you are located is not listed or if you need more precise coordinates, enter the exact latitude and longitude of your location in the appropriate text boxes. Knowing your initial coordinates decreases the amount of time it takes for your receiver to acquire a fix on your position. If you have a map downloaded, you can use its coordinates to initialize. After selecting the desired map, select the Map Center option from the State drop-down list. 5. From the Device drop-down list, select the type of GPS receiver you are using. If your device is not listed, select NMEA183. (Use the keyboard arrow keys to scroll through the options.) 6. From the Port drop-down list, select the communications port that you are using to attach the GPS receiver to your computer (see your computer manual for further information). 7. The GPS Status box on the right indicates whether or not you are receiving satellite information. "No Fix" means that the GPS receiver has not been detected or you are not receiving enough information to determine a fix. "Acquiring Satellites" indicates that the GPS receiver is acquiring satellite information, but is not yet receiving sufficient satellite data to determine your position. This message is displayed while the receiver is acquiring satellite data and can take several minutes. "2-D Nav" indicates that you are receiving data, but it is not sufficient to determine your elevation. "3-D Nav" indicates that you are receiving ample data and have a good fix. 8. A stream of data in the center of the screen indicates that you are receiving signals from satellites. 9. Select the Log option if you want to log your GPS route as you track. 10. Use the slider to change the GPS log rate (2-10 seconds). This determines the rate at which the satellite information is updated in the program. 11. Tap the OK button to close out of the Initialize GPS dialog box. NOTE: In order to conserve batteries, be sure to disconnect the adapter cable when not using DeLorme's GPS receiver with your H/PC.

Detailed Description Paragraph Table (5):
To track: 1. Connect your H/PC to DeLorme's GPS receiver with DeLorme's Windows CE adapter cable (available separately from DeLorme). 2. After you have sent your route to the H/PC, tap the Solus Pro icon on the desktop to open the program. 3. Tap the Connect tool on the command bar or choose GPS . . . Connect . . . to begin communication between Solus Pro and your GPS receiver. A message appears at the top of the screen indicating the status of your GPS connection. "Connecting" indicates that Solus Pro is attempting to communicate with the GPS receiver. "Acquiring Satellites" indicates that the GPS receiver is acquiring satellite information, but is not yet receiving sufficient satellite data to determine your position. This message is displayed while the receiver is acquiring satellite data and can take several minutes. "2-D Nav" indicates that you are receiving data, but it is not sufficient to determine your elevation. "3-D Nav" indicates that you are receiving ample data and have a good fix. 4. After achieving 3-D Nav status, you have three tracking options: if you want to track using your Directions, tap the Route Directions tool to view the Directions that you calculated in Topo USA. As you travel, Solus Pro highlights the next road you will use and beeps 60 seconds before your next route change. If you want to track using a map, tap the Map tool to view the map that you created in Topo USA. Your position is indicated on the map by crosshair as you travel. You can also track in the Navigate mode. Tap the Navigate tool to view your current route status. The instructions for your next route change appear at the bottom of the screen and update as you travel. The time and distance to your Finish appear above. 5. Choose GPS . . . Disconnect to stop displaying your route on the screen. NOTE: In order to conserve batteries, be sure to disconnect the adapter cable when not using DeLorme's GPS receiver with your H/PC .rect-hollow.

CLAIMS:

1. An integrated routing/mapping information system (IRMIS) comprising:

a first digital computer having a first computer display;

a database including a set of electronic maps of varying and selectable magnitude for

presentation on said first computer display, wherein said electronic maps have the capability of depicting transportation routes having identifiable waypoints including route intersections at geographical locations along said transportation routes, said identifiable waypoints on said electronic maps being identifiable in said first computer by coordinate locations of a selected geographical coordinate system; software means permitting user travel planning using said electronic maps presented on said first computer display by providing user selection of selected waypoints that include at least a travel origin and a travel destination and can include intermediate waypoints, wherein said software means is capable of calculating, delineating, and displaying a travel route between said travel origin and said travel destination, wherein said travel origin and said travel destination are identifiable in said first computer by coordinate locations of said geographical coordinate system;

a second digital computer having a second display;

means for coupling said first digital computer to said second digital computer for the transfer of data therebetween;

IRMIS software for selectably transferring from said first digital computer to said second digital computer said travel route. one or more of said electronic maps, or a combination thereof,

wherein said IRMIS software is constructed to present a view on said second computer display of said travel route, said one or more electronic maps, or said combination thereof.

4. The IRMIS of claim 3 wherein said selected geographical coordinate system is a standard latitude/longitude (lat/long) geographical coordinate system and wherein coordinate locations are stored in said second digital computer as lat/long coordinates, and said geocoding-capable device is a global positioning system (GPS) receiver.

5. The IRMIS of claim 4 wherein said GPS receiver is coupled to said second digital computer, and wherein said IRMIS software receives positioning information from said GPS receiver and adjusts an output of travel update information and electronic map displays on said second display as a function of said positioning information.

7. The IRMIS of claim 1 wherein said database includes maps of selectable levels of detail, wherein said IRMIS software includes means for automatically increasing a level of detail for display on said second computer display of said electronic maps associated with said travel route at or near said travel origin and said travel destination, and means for automatically decreasing said level of detail for display on said second computer display of said electronic maps associated with said travel route in the area between said travel origin and said travel destination.

8. An integrated routing/mapping information system (IRMIS) comprising:

a digital computer having a computer display;

a database accessible by said digital computer, said database including a set of electronic maps of varying and selectable magnitude and capable of presentation on said computer display;

IRMIS software designed to enable user travel planning using said electronic maps presented on said computer display by providing user selection of selected waypoints that include a travel origin and a travel destination, wherein said IRMIS software is capable of calculating, delineating, and displaying on said computer display a travel route between said travel origin and said travel destination;

means for coupling said digital computer to one or more other computers for the exchange of data therebetween; and

wherein said IRMIS software is designed to selectably transfer from said digital computer to said one or more other computers said travel route and one or more electronic maps of said database associated with said travel route.

11. The IRMIS of claim 10 wherein said database further includes identifiable waypoints associated with said travel route, wherein said waypoints are identifiable by coordinate means of a selected geographical coordinate system, wherein said selected geographical coordinate system is a standard latitude/longitude (lat/long) geographical coordinate system and wherein coordinate locations are storable in said one or more other computers as lat/long coordinates, and said geocoding-capable device is a global positioning system (GPS) receiver.

12. The IRMIS of claim 11 wherein said GPS receiver is coupled to said one or more other computers, and wherein said IRMIS software receives positioning information from said GPS receiver and adjusts an output of travel update information and electronic map displays on said one or more other computers as a function of said positioning information.

15. The IRMIS of claim 8 wherein said database includes maps of selectable levels of detail, wherein said IRMIS software includes means for increasing a level of detail for display on any of said one or more other computers of said electronic maps associated with said travel route at or near said travel origin and said travel destination, and means for decreasing said level of detail for display on said one or more other computers of said electronic maps associated with said travel route in the area between said travel origin and said travel destination.

16. A system for exchanging map-related information among two or more computer systems, the system comprising:

a digital computer having a computer display;

a database of geographical-coordinate-locatable objects (loc/objects) accessible by said digital computer, said database including a set of electronic maps of varying and selectable magnitude and capable of presentation on said computer display, wherein said electronic maps are associated with map grid quadrangles, wherein said loc/objects of said database are identified by geographical coordinate identifiers in a geographical coordinate system, and wherein said loc/objects may be displayed on said computer display;

means for coupling said digital computer to one or more other digital computers for the exchange of data therebetween; and

software means designed to enable display on said one or more other computers one or more electronic maps of said database with associated map grid quadrangles that correspond to said map grid quadrangles and that may further correspond to paper map grid quadrangles of one or more printed maps.

18. A system for exchanging travel-related geographical information among two or more computer systems, the system comprising:

a computer system including a computer display;

a map database providing a set of electronic maps for presentation on the computer display;

said electronic maps depicting one or more transportation routes having waypoints at geographical locations along the one or more transportation routes, wherein said waypoints may be depicted on the electronic maps and are identified by coordinate locations;

a database of one or more geographically locatable points of interest (POIs) identified by coordinate locations, said POIs being organized into a plurality of types and for display on said computer display;

software means designed to enable user travel planning using said electronic maps presented on the computer display, said software means permitting user selection of a travel origin and a travel destination from among said waypoints, wherein said software means is designed to calculate and display on said computer display a travel

route between the travel origin and t he travel destination;

said software means is also designed to enable the user to select a region of interest along the travel route and to display within said region of interest one or more of said POIs;

said database comprising travel information selected from the group consisting of graphics, photos, videos, animations, audio information, text information, and combinations thereof about said POIs; and

said software means is further designed to present on the computer display the travel route and said travel information associated with said POIs within said region of interest.

19. A system for exchanging travel-related geographical information among two or more computer systems, the system comprising:

a computer system including a computer display;

a map database providing a set of electronic maps for presentation on the computer display;

said electronic maps depicting one or more transportation routes having waypoints at geographical locations along the one or more transportation routes, wherein said waypoints may be depicted on the electronic maps and are identified by coordinate locations;

a database of one or more geographically locatable points of interest (POIs) identified by coordinate locations, said POIs being organized into a plurality of types and for display on said computer display;

software means designed to enable user travel planning using said electronic maps presented on the computer display, said software means permitting user selection of a travel origin and a travel destination from among said waypoints, wherein said software means is designed to calculate and display on said computer display a travel route between the travel origin and the travel destination;

said database comprising travel information selected from the group consisting of graphics, photos, videos, animations, audio information, text information, and combinations thereof about said POIs;

said software means is further designed to present on the computer display the travel route and said travel information associated with said POIs within said region of interest;

means for coupling said computer system to one or more other computer systems for the exchange of data therebetween; and

wherein said software means is designed to selectably transfer from said computer system to said one or more other computer systems said travel route and said travel information associated with said POIs within said region of interest.

21. An integrated routing/mapping information system (IRMIS) comprising:

a digital computer having a computer display;

a database accessible by said digital computer, said database including a set of electronic maps of varying and selectable magnitude and capable of presentation on said computer display;

IRMIS software designed to enable user travel planning using said electronic maps presented on said computer display by providing user selection of selected waypoints that include a travel origin and a travel destination, wherein said IRMIS software is capable of calculating, delineating, and displaying on said computer display a travel route between said travel origin and said travel destination;

means for coupling said digital computer to one or more other computers for the exchange of data therebetween;

wherein said IRMIS software is designed to selectably transfer from said digital computer to said one or more other computers said travel route and one or more electronic maps of said database associated with said travel route; and

wherein said database includes maps of selectable levels of detail, wherein said IRMIS software includes means for increasing a level of detail for display on any of said one or more other computers of said electronic maps associated with said travel route at or near said travel origin and said travel destination, and means for decreasing said level of detail for display on said one or more other computers of said electronic maps associated with said travel route in the area between said travel origin and said travel destination.

22. A system to manipulate on a display of a computer device one or more maps or travel-related information in response to positioning information received by the computer device from a positioning device, the system comprising:

a map database providing a set of electronic maps for presentation on the computer display;

said electronic maps depicting one or more transportation routes having waypoints at geographical locations along the one or more travel routes, wherein said waypoints may be depicted on the electronic maps and are identified by coordinate locations;

a database of one or more geographically locatable points of interest (POIs) identified by coordinate locations, said POIs being organized for display on said computer display;

means for coupling the computer device to a global positioning system receiver that outputs one or more travel-route-related parameters; and

software means for generating on the computer travel-related information associated with one or more of said electronic maps, one or more of said POIs, or any combination of both, wherein said travel-related information is associated said one or more travel-route-related parameters.

25. The system as claimed in claim 22 wherein said travel-related information is selected from the group consisting of: map scale, map magnitude, map detail, text messages, audio messages, graphic representations, types of POIs, classes of POIs, supplemental POI information, route information, route directions, and position on map display.

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L11: Entry 62 of 86 File: USPT May 6, 1997

DOCUMENT-IDENTIFIER: US 5627547 A
TITLE: Mapless GPS navigation system in vehicle entertainment system

Abstract Paragraph Left (1):
A navigation system is provided for offering navigational assistance to a mobile user. The navigation system receives GPS position information signals which are processed to determine current position latitude and longitude coordinates and direction of travel. A destination database includes a plurality of categorized destinations and corresponding destination position coordinates pertaining to the destinations. The destination database is stored on an interfacable memory card and contains menu categories and subcategories for classifying the destinations and additional text information pertaining to the destinations. User selectable menu controls enable the user to sequence through the menu of categories and destinations and select a desired destination. This is easily accomplished by rotating a rotary pushbutton to view category and destination selections and depressing the rotary pushbutton to select the selection shown. A processor compares the current position coordinates with the position coordinates of the selected destination and determines a distance and a straight-line direction from the current position to the selected destination. A display displays the distance and a direction pointing indicator for showing the direction from the current position to the selected destination. In one embodiment, the navigation system is integrated with an audio entertainment system and shares a common display and housing.

Brief Summary Paragraph Right (2):
This invention relates generally to navigation systems and, more particularly, to a mapless GPS based direction pointing navigation system integrated in a vehicle entertainment system such as a car radio and sharing a common display.

Brief Summary Paragraph Right (4):
The concepts of intelligent vehicle highway systems (IVHS) are changing the future of ground transportation systems. In particular, navigation systems have been developed and are increasingly becoming available for use in assisting a mobile user. For example, on-board navigation systems are currently provided in some automotive vehicles to assist the driver of the vehicle in navigating the vehicle along a route or roadway system to reach a desired destination.

Brief Summary Paragraph Right (5):
Early navigation systems generally did not have the availability of advanced positioning systems such as global positioning system (GPS). Instead, a number of early navigation systems often relied exclusively on dead reckoning techniques to account for a moving vehicle's location. Generally speaking, dead reckoning is the determination of position by advancing a known position using measured courses and distances. This generally involved determining a starting location and manually setting the vehicle's position on an electronic map. With the use of a dead reckoning technique, an approximate path of travel of the vehicle could be computed and updated as the vehicle was driven. The travel path determination was often achieved by way of a compass reading and vehicle speed information or was achieved by some other kind of dead reckoning technique. However, many of the dead reckoning based navigation systems often failed to provide accurate and continuous navigation assistance and therefore required repeated corrections to the vehicle's computed position.

Brief Summary Paragraph Right (6):

The development of the global positioning system (GPS) by the United States Department of Defense has greatly enhanced the ability to navigate. Currently, a constellation of satellites are in place orbiting the earth at high altitudes and transmitting radio waves which contain position information. With the use of GPS receivers, the position information can be received and used to calculate the current latitude and longitude position coordinates at the receiving location. The global positioning system is currently achieving recognition as the superior position locator system for providing accurate worldwide fixes.

Brief Summary Paragraph Right (7):
With the widespread availability of GPS, more recent navigation systems now rely on GPS to provide position information to compute a vehicle's position. According to one approach, the computed position of the vehicle is contrasted to a digitized map. This technique, also known as map matching, requires a complex digitized map database and normally uses an expensive full function detailed map display to show the digitized map in relation to the vehicle's position. The digitized map database has to consider one-way street information, turn restrictions and other roadway requirements. Often with the use of a complex algorithm, a computer would attempt to compute a best route from the vehicle's current position to a desired destination, considering all available street changes and travel restrictions. This results in turn-by-turn instructions in which a driver is instructed to turn left or right or proceed straight ahead on each approaching street.

Brief Summary Paragraph Right (8):
The use of map matching navigation and other similar full function navigation systems has generally provided a user with the ability to follow calculated turn-by-turn instructions as computed by the navigation system. However, map matching techniques generally do not take into consideration changes in travel routes and roadway restrictions. That is, changes in a transportation system which often occur, especially on roads subjected to road construction, remain unaccounted for. Also, some drivers may feel that the expensive full function displays may tend to cause the drivers to rely too heavily on the map display for driving instructions rather than for mere assistance. They therefore may feel that such displays are too distractive. Furthermore, most full function navigation systems are commercially available at a very high cost which often makes the systems unaffordable to a vast majority of consumers.

Brief Summary Paragraph Right (9):
Additionally, the commercially available full function navigation systems require a separate active matrix with an expensive mappable graphics display such as a liquid crystal display (LCD). Detailed mappable displays such as the LCD tend to be rather bulky and difficult to mount in a vehicle for easy viewing. In addition, the on-board computer and associated electronics in several conventional full function navigation systems are separately packaged and difficult to accomodate in a vehicle.

Brief Summary Paragraph Right (10):
It is therefore desirable to provide a low cost and easy-to-use navigation system which offers navigational assistance to a mobile user for traveling to desired destinations.

Brief Summary Paragraph Right (11):
More particularly, it is desirable to provide a mapless navigation system that employs global positioning system signals and destination database and provides destination direction pointing assistance in a manner which is affordable to many users.

Brief Summary Paragraph Right (12):
It is further desirable to provide a mapless navigation system which may easily be integrated into an audio entertainment system and installed in an automotive vehicle for use in assisting the driver of the vehicle to reach a desired destination.

Brief Summary Paragraph Right (13):
Yet, it is also desirable to provide such a navigation system which shares a common display with an audio entertainment system to display navigational information.

Brief Summary Paragraph Right (14):

In accordance with the teachings of the present invention, a mapless navigation system is integrated with a vehicle entertainment system for providing navigational assistance to a mobile user. The navigation system includes a position sensing receiver for receiving position information signals. The position information signals are processed to determine position latitude and longitude coordinates. The navigation system has a destination database containing a plurality of categorized destinations, destination position coordinates and information pertaining to the destinations. User selectable menu controls are provided to sequence through and select a destination and text information. A processor receives the current position and a selected destination and determines a straight-line distance and a direction from the current position to the selected destination. The navigation system shares a common display with the audio entertainment system. The display may provide the distance and a direction pointing indicator for providing a visual straight-line indication of the direction from the current position to the selected destination. In addition, the display may display position coordinates, menu selections and destination information when in the navigation display mode.

Brief Summary Paragraph Table (1):

U.S. Ser. No. Title
R. Brunts 08/418931 LOW COST NAVIGATION A. Ramaswamy SYSTEM WITH DESTINATION D. Welk DATABASE R. Brunts 08/419002 MAPLESS GPS NAVIGATION D. Welk SYSTEM WITH USER MODIFIABLE DATABASE R. Brunts 08/419932 MAPLESS GPS NAVIGATION D. Welk SYSTEM WITH RADIALLY SORTABLE DESTINATIONS R. Brunts 08/418934 MAPLESS GPS NAVIGATION D. Welk SYSTEM WITH ROTARY PUSH BUTTON USE INTERFACE CONTROL A. Ramaswamy 08/418809 PCMCIA CARDS AS D. Welk REPLACEABLE MEMORY IN R. Brunts GPS NAVIGATION SYSTEM

Drawing Description Paragraph Right (2):
FIG. 1 is a front view of a navigation system packaged by itself according to one embodiment of the present invention;

Drawing Description Paragraph Right (3):
FIG. 2 is a front view of the navigation system integrated with an audio entertainment system in accordance with another embodiment of the present invention;

Drawing Description Paragraph Right (6):
FIG. 5 is a view of an automotive vehicle equipped with the navigation system of the present invention;

Drawing Description Paragraph Right (7):
FIG. 6 is a schematic view of the display graphics employed by the navigation system of the present invention;

Drawing Description Paragraph Right (8):
FIG. 7 is a perspective view of a head-up-display which may be employed to supplement the display of FIG. 6 according to an alternate embodiment;

Drawing Description Paragraph Right (9):
FIG. 8 illustrates a readable PCMCIA standard memory card which contains categorized destinations and destination information in a data base;

Drawing Description Paragraph Right (10):
FIG. 9 illustrates categories, categorized destinations and destination information contained in the data base that is stored on the memory card of FIG. 8;

Drawing Description Paragraph Right (11):
FIG. 10 illustrates menu selections which are available with the navigation system according to one example;

Drawing Description Paragraph Right (13):
FIG. 12 illustrates the use of the navigation system for assisting a driver of a vehicle to reach a selected destination according to one example;

Drawing Description Paragraph Right (14):
FIG. 13 is a flow diagram illustrating a methodology of providing position updates

with the navigation system of the present invention;

Drawing Description Paragraph Right (15):
FIGS. 14A through 14C illustrate a sequencing of menu selections and displays when selecting a destination and destination information from the memory card destination data base; FIG. 14A shows selection of a fast food destination; FIG. 14B further shows selection of a fast food destination from a group of same name destinations; and FIG. 14C illustrates the menu selection sequencing and displays with a sort by distance operation;

Drawing Description Paragraph Right (16):
FIG. 15 illustrates a sequencing of menu selections and displays when entering a destination by latitude and longitude position coordinates in the latitude/longitude menu mode; and

Drawing Description Paragraph Right (17):
FIGS. 16A through 16E illustrate sequencing of menu selections and displays when saving and recalling stored destinations and information in a user programmable memory when in the save/recall menu mode; FIG. 16A illustrates saving the current position as a destination; FIG. 16B illustrates saving the last selected data base destination; FIG. 16C illustrates saving a destination from the latitude/longitude menu mode; FIG. 16D illustrates recalling user stored destinations which were stored from the data base; and FIG. 16E illustrates recalling user stored destinations which were stored as latitude/longitude position coordinates.

Detailed Description Paragraph Right (1):
Turning now to FIGS. 1 and 2, a mapless navigation system is shown according to two embodiments 10A and 10B of the present invention for providing navigation services. The navigation system 10A of FIG. 1 is configured as a stand-alone navigation unit. The navigation system 10B of FIG. 2 is integrated into an audio entertainment system of the type generally configured for installation in an automotive vehicle. Both embodiments of the navigation system 10A and 10B contain similar navigation related components and provide the same or substantially similar navigation services. Accordingly, the navigation system is often generally referred to herein as reference numeral 10. Like components in both system embodiments of 10A and 10B share like reference numerals.

Detailed Description Paragraph Right (2):
Referring particularly to FIG. 1, the stand-alone navigation system 10A has a face plate 12A assembled on the front side of a generally rectangular housing. The housing may include two side mount brackets (not shown) integral to housing and a rear mounted stud (also not shown) for mounting to a supportive structure. For automotive vehicle use, the housing is preferably mounted or integrated within the instrument panel (IP) of an automotive vehicle in a manner similar to the mounting of a car radio. However, the stand-alone navigation system 10A could be employed as a portable hand-held navigation unit and used for a wide variety of navigational applications.

Detailed Description Paragraph Right (3):
Extending from the face plate 12A of navigation system 10A are several manually selectable controls for controlling various navigational functions. Included is an "ON/OFF" pushbutton control 14, a "MENU CHOICES" rotary/pushbutton control 16, a navigation menu selection "NAV MENU" pushbutton 18, an "UNDO" selection pushbutton 22, an information "I" pushbutton 20, a sort by distance "SORT" pushbutton 24, a current position "POS" pushbutton 26 and a direction heading pushbutton 28.

Detailed Description Paragraph Right (4):
The navigation menu selection pushbutton 18, when manually depressed, displays the navigation main menu. The navigation main menu contains three navigation menus, namely, a destination menu, a latitude/longitude menu, and a save/recall menu. The menu choices rotary/pushbutton 16 is rotatable to switch between various selections of a selected navigation menu and depressible to select the option that is currently displayed. The undo pushbutton 22 will undo the last selection and return to the previous selection. Repeatedly pressing the undo pushbutton 22 will continue to undo the previous selections until the display 30 returns to the main navigation menu. The information pushbutton 20 will retrieve alphanumeric text information pertaining to a

selected destination. The sort by distance pushbutton 24 initiates a sorting function for sorting destinations based on distance from a particular location. The position pushbutton 26 displays the current latitude and longitude position coordinates, while direction heading pushbutton 28 provides the current vehicle direction heading.

Detailed Description Paragraph Right (5):
The navigation system 10A includes a navigation guidance display 30 for displaying a direction pointing arrow 32 and alphanumeric text 34. The direction pointing arrow 32 points in the straight-line direction toward a selected destination. The alphanumeric text 34 may include various destination names, distances, menu selection names, latitude and longitude position coordinates, current direction heading readings, time of day and other alphanumeric text information. After a specific destination is selected, the text information 34 may include the name of the selected destination and the straight-line distance from the current position of the navigation system 10A to the selected destination. The direction pointing arrow 32 and distance readings are continually updated in response to sensed GPS signals and can be maintained when GPS is unavailable with the use of a back-up dead reckoning technique.

Detailed Description Paragraph Right (6):
Because the number of predetermined destinations can be enormous, we prefer to group selected types of destinations into separate data bases and to store each data base on a separate readable memory card. Hence, only small data bases need be used. This feature of the invention permits use of a wide variety in types of destination groupings, as will hereinafter be explained. The memory card is about the size of a credit-card and is preferably formatted to PCMCIA standards. Use of PCMCIA standard connections to the card not only help maintain low cost but also provides other advantages which also will hereinafter be explained.

Detailed Description Paragraph Right (7):
To accommodate a large number of destinations, a plurality of memory cards are made available to select from. Each memory card would contain a selected type of data base as for example a camping information directory, a business directory, a restaurant/hotel directory, etc. for covering a given geographic area. Each memory card provides categorized destinations with corresponding latitude and longitude position coordinates within a predefined territory and also includes alphanumeric text information pertaining to each of the destinations. For example, a business directory data base may provide business names, address locations, phone numbers and business operating hours, as well as other types of information.

Detailed Description Paragraph Right (8):
To access the destination information, the navigation system 10A is equipped with a memory card interface 36. With the appropriate memory card inserted in memory card interface 36, thousands of destinations are available for exploration. Since the PCMCIA memory cards are relatively small and of a standard interface type, their cost is minimized. Also, the PCMCIA memory card is small enough to allow one to carry a plurality of cards in a vehicle without an undue burden. Still further, the PCMCIA memory card could be readable by an ordinary computer having a compatible program, and thus given it an alternate use for accessing information on computers which are compatible with the PCMCIA standard memory card.

Detailed Description Paragraph Right (9):
Businesses with many outlets, offices or affiliates may find it economically worthwhile to compile data bases that include and/or favor themselves, and to distribute such data bases on PCMCIA memory cards to potential customers at no or low cost. For example, a golf organization may find it advantageous to distribute PCMCIA memory cards equipped with a desired data bases to its members and potential members or customers. Such a marketing strategy will enable the card holder to navigate to destinations affiliated with the organization.

Detailed Description Paragraph Right (10):
Still further, the PCMCIA memory card could be made with programmable memory that is inherently non-volatile or that has a battery back-up on the card. Such a memory card is more expensive but would offer added flexibility in programming. A user could therefore save destination-related information on such a programmable memory card. One could even program such a programmable PCMCIA card with selected destinations on one's

personal computer and then use the PCMCIA memory card in a navigation system such as that described herein. A patent application on such a programmable memory card is expected to be filed.

Detailed Description Paragraph Right (11):
Accordingly, use of the PCMCIA memory card for replaceable memory in this invention opens up a myriad of possibilities for types of data bases that might be stored on them for use in the navigation system 10 of this invention.

Detailed Description Paragraph Right (12):
With particular reference to FIG. 2, the navigation system 10B is integrally packaged with an audio entertainment system and contains substantially the same navigation components and features provided in the stand-alone navigation system 10A. The navigation/audio entertainment system 10B has a face plate 12B which likewise includes the "MENU CHOICES" rotary/pushbutton 16, navigation menu "NAV MENU" pushbutton 18, information "I" pushbutton 20, "UNDO" pushbutton 22, sort by distance "SORT" pushbutton 24, position "POS" pushbutton 26 and current direction heading pushbutton 28. The integrated navigation/audio entertainment system 10B similarly has a guidance display 30 that is commonly shared among the navigation, audio radio and audio cassette tape modes of operation. That is, display 30 will provide the direction indicating arrow 32 with the destination information 34 when in the navigation display mode. However, display 30, when in the audio radio display mode, will generally display AM or FM frequency selections in addition to the time of day and various types of radio related information. When in the audio cassette tape display mode, the display 30 will display information pertaining to the cassette tape operation.

Detailed Description Paragraph Right (15):
While the preferred embodiment of the navigation/audio entertainment system 10B includes an AM/FM radio and audio cassette tape player integrated with the navigation system in FIG. 2, it should be appreciated that other audio entertainment systems or combinations of audio systems may be combined with the navigation system. For example, an audio compact disc (CD) player could be employed in addition to or in place of the audio cassette tape player 46. Alternately, an externally located compact disc (CD) changer could be electrically coupled to the radio tuner and operated in conjunction with the radio. It is also conceivable that destination-related information could be stored on and retrieved from a compact disc or cassette.

Detailed Description Paragraph Right (16):
Referring to FIGS. 3 and 4, the navigation/audio entertainment system 10B is further shown to include various interconnected electronics and processing components and signal inputs. As mentioned above, the face plate 12B encompasses shared display 30 and the various user controls as represented by key matrix 60. The housing of system 10B is generally represented by reference numeral 61. Packaged within housing 61 is the audio cassette tape player 46, memory card interface 36, a radio control board 62 and a navigation board 68. The radio control board 62 is connected to a radio tuner 64 and the audio cassette tape player 46. The radio tuner 64 is further coupled to an externally located radio antenna 66 for receiving radio wave signals. In addition, audio speakers 65 are generally coupled to the radio control board 62.

Detailed Description Paragraph Right (17):
The radio control board 62 communicates with the navigation board 68 via an array of communication lines including SPI and WAKEUP lines. The navigation board 68 is connected to the memory card interface 36 and a GPS receiver 70. The GPS receiver 70, in turn, is connected to a GPS antenna 72. According to well known GPS operations, the GPS receiver 70 receives GPS radio wave signals which are emitted from existing GPS satellites and received via the GPS receiving antenna 72. Currently, a constellation of high altitude GPS satellites are in orbit and available to provide continuous worldwide position fixes in all types of weather conditions. The GPS receiver 70 has a built-in processing unit and memory for processing the GPS radio wave signals to determine the latitude and longitude coordinates of the current position, as well as determining the current direction of travel.

Detailed Description Paragraph Right (18):
More specifically, the GPS receiver 70 continuously receives radio wave signals from the GPS antenna 72 and determines accurate position coordinates which identify the

location of the received signals. This determination includes calculating the distance from various satellites to determine a location relative thereto. By measuring the current signals sent by the GPS satellites and knowing orbital parameters of the satellites, the GPS receiver 70 is able to determine the location thereof and generate longitude and latitude position coordinates identifying the position of the received signals.

Detailed Description Paragraph Right (19):
More particularly, with the received GPS signals, the latitude and longitude position coordinates of the GPS receiver 70 are determined by computing distance from each of several GPS satellites currently visible to the receiver 70 by direct line-of-sight. Distance is determined by precise computation of the time required for radio signals to travel from the GPS satellite to the GPS receiver 70. Combined with precise information about the satellites' positions relative to the earth, precise latitude and longitude coordinates are computed.

Detailed Description Paragraph Right (20):
At speeds greater than a few miles per mile, the GPS receiver 70 can also determine a precise direction of travel. The receiver 70 determines rate of change in range or relative speed to each visible satellite. Combined with precise knowledge of satellite orbits and the earth's rotation, the ground velocity (i.e., speed and direction) of the GPS receiver 70 can be precisely determined. The determined direction heading is preferably used as a reference while the vehicle is moving at a speed of greater than five miles per hour, for example.

Detailed Description Paragraph Right (21):
GPS is widely known and should be understood to those skilled in the art as a means for providing accurate position location information with an accuracy within one-hundred (100) meters or better for over ninety-five percent (95%) of the time. It should also be understood that enhanced accuracy may be obtained with GPS now and in the future. For example, a differential receiver could also be employed to provide the availability of differential GPS which offers enhanced position determining accuracy.

Detailed Description Paragraph Right (22):
The navigation board 68 receives a number of signal inputs which include a signal indicative of the vehicle direction heading as generated by a magnetic flux gate compass 74 according to one embodiment. According to a second embodiment, the direction heading signal may alternately be generated with a gyro compass. The gyro compass offers the advantage of immunity to magnetic noise such as is common in urban environments and near power distribution centers. Accordingly, the gyro compass may be more desirable when GPS blockages combined with high magnetic noise levels can be expected. The direction heading indication provided by compass 74 is used as backup heading information which serves as a reference for determining straight-line direction to a selected destination when the vehicle's speed drops below five miles per hour. The direction heading signal from compass 74 is also is used with the back-up dead reckoning system when GPS is unavailable.

Detailed Description Paragraph Right (23):
Additionally, a vehicle speed sensor (VSS) signal 76 is received by the navigation board 68 to provide an indication of vehicle speed. Also received by the navigation board 68 is a transmission position (PRNDL) signal 78 which provides an indication of a forward or reverse direction of travel of the vehicle. Together, the direction heading signal provided by a compass 74, as well as the vehicle speed sensor signal 76 and transmission position signal 78 allow for the backup dead-reckoning system to complement the GPS position coordinates.

Detailed Description Paragraph Right (25):
The navigation board 68 also contains its own navigation control microprocessor 92 for controlling the primary navigation functions of the present invention. The microprocessor 92 has built-in random access memory (RAM), electronically erasable programmable memory (EEPROM) 98, read only memory (ROM) 100, a serial input/output 102 and an input/output 104. The EEPROM 98 and ROM 100 generally contain the necessary programmed instructions for performing the primary calculations to determine distance and direction to selected destinations. Also included on the navigation board 68 is random access memory (RAM) 94 and the memory card interface 36. The random access

memory (RAM) 96 or 94 preferably contains programmable memory locations for storing destination information and for continually storing variables used to determine the direction and distance information as processed by the navigation control microprocessor 92.

Detailed Description Paragraph Right (26):
The GPS receiver 70 also includes a built-in GPS control microprocessor 106 and random access memory (RAM) 108. Microprocessor 106 also contains built-in random access memory (RAM) 107. The random access memory (RAM) 107 or 108 preferably stores the radio wave signals received from the GPS receiving antenna 72 for processing. The GPS control microprocessor 106 processes the received radio wave signals and calculates the current latitude and longitude position coordinates thereof in addition to calculating the current direction of travel. The calculated position coordinates and direction data may thereafter be stored in RAM 107 or 108.

Detailed Description Paragraph Right (27):
According to a preferred embodiment, the navigation system 10 may easily be mounted in an automotive vehicle 110 as shown in FIG. 5. According to the automotive vehicle application, the navigation system 10 may easily be mounted within the dash of the vehicle 110 in a manner similar to the mounting of a car radio. Accordingly, the key matrix 60 and display 30 are easily accessible by the driver or a passenger in the vehicle 110. The magnetic flux compass 74 is located near the upper midportion of the windshield near or within the rearview mirror assembly. The vehicle speed sensor (VSS) signal 76 and transmission position (PRNDL) signal 78 are taken from the vehicle transmission. The GPS antenna 72 is preferably mounted on the roof of the vehicle 110 and exposed to GPS radio wave signals.

Detailed Description Paragraph Right (28):
With particular reference to FIG. 6, the display 30 is shown in an enlarged schematic view. The display 30 is a simplistic and inexpensive alphanumeric text with direction pointing arrow display. According to one embodiment, display 30 is a vacuum fluorescent (VF) display. Alternately, display 30 may include a liquid crystal display (LCD) equipped with back-lighting. Other similar simplistic and inexpensive displays which can produce a variable straight-line direction pointing arrow or the like and alphanumeric text can alternately be employed.

Detailed Description Paragraph Right (29):
The display 30 shown includes a direction pointing arrow display 112 containing a plurality of equi-angular direction pointing arrows such as arrow 32. According to the embodiment shown, direction pointing display 112 includes sixteen possible arrow selections equi-angularly displaced 22.5.degree. about a 360.degree. rotation. The appropriate direction pointing arrow such as arrow 32 is selected and actively displayed as a darkened arrow to provide an indication of the straight-line direction from the current position of the GPS receiver 70 to a selected destination. The arrow direction may vary and is determined by the calculated direction as referenced to the current vehicle heading provided by the GPS receiver 70 or backup compass 74. The direction pointing arrow 32 pointing upward indicates that the destination is directly ahead of the vehicle, while the direction pointing arrow 32 pointing downward indicates that the destination is directly behind the vehicle. The direction pointing arrow 32 pointing to the right indicates that the destination is to the right and that the driver of the vehicle may turn the vehicle when appropriate. Likewise, the direction pointing arrow 32 pointing to the left indicates that the destination is to the left.

Detailed Description Paragraph Right (30):
The navigation display 30 further includes alphanumeric character displays 114 for displaying alphanumeric characters. Character displays 114 each preferably include an array of segments, pixels or a dot matrix for economically displaying alphanumeric characters such as individual alphabetical, numeric or other symbolic characters. The display 30 is equipped with a limited number of character displays 114. As shown, a total of twenty-four character displays 114 are divided between a top line and a bottom line of text. The text information 34 may include various menu categories, sub-categories, destinations, distance information, and a wide variety of alphabetical, numerical and text information. As shown in FIG. 6, a destination name 116 is provided on the top line. Displayed on the bottom line is a distance as

determined from the current position to the selected destination. While the distance shown is displayed in miles, the metric equivalent of the distance in kilometers (km) could likewise alternately be displayed.

Detailed Description Paragraph Right (31):
The navigation system 10 of the present invention may further employ a head-up-display 148 as shown in FIG. 7. The head-up-display 148 provides an easy to view image of the vehicle speed looking through the front windshield when driving a vehicle. The head-up-display 148 may further show the straight-line direction pointing arrow 32 and distance information 118 as a complement to the display 30. The added use of the head-up-display 148 allows for easy viewing of the direction and distance so the vehicle driver can easily view the continuously updated navigation information while driving the vehicle.

Detailed Description Paragraph Right (32):
Referring to FIG. 8, a preferred memory card 120 that is used to provide a categorized destination data base is shown therein. According to one embodiment, the memory card 120 is formatted to PCMCIA standards and contains selectable destinations in a categorized business directory data base that is stored on read only memory (ROM) within the memory card 120. One example of the PCMCIA memory card 120 is Model No. FE02M-20-10038-01 manufactured and sold by Centennial Technologies, Inc. This particular memory card 120 has a PCMCIA standard interface which includes a total of sixty-four female electrical connector holes 122 provided at the connector end for receiving pin connectors within the memory card interface 36. It should be appreciated that a plurality of memory cards 120 may be selected from to view desired destinations and destination-related information made available for a predefined geographic territory. By inserting the appropriate metropolitan area memory card into the memory card interface 36, thousands of destinations become available for exploration by a user. In doing so, a user may select from the various categories and sub-categories to find a desired destination from the destination database on the memory card 120.

Detailed Description Paragraph Right (33):
As previously mentioned, the destination data base memory card 120 contains a plurality of destinations arranged in a menu hierarchy of categories and sub-categories. According to one embodiment, the destination data base memory card 120 may contain programmed destination information as provided in FIG. 9. As shown, a plurality of destination categories 124 are provided which may include category selections such as food, hotel, gas, and other identifiable destination categories. Within each of the destination categories 124 may be a plurality of sub-categories 126. For example, within the food category may be sub-categories 126 which include fast food, casual dining, fine dining among other food sub-categories. Within the data base hierarchy of sub-categories, there may be another sub-category 128. For example, the sub-category 126 for casual dining may include further sub-categories 128 such as Chinese food, fish bar, Italian dining, pizza and steak house and other possible casual dining sub-categories.

Detailed Description Paragraph Right (34):
It should be appreciated that various levels of categories and sub-categories may be provided and selectively sequenced through to access the desired destination name, destination position coordinates and related destination information. When selecting the destination category 124, and any sub-category such as sub-categories 126 and 128, a plurality of destinations may be selected from as provided in block 130. For each destination, the corresponding latitude and longitude position coordinates are provided as shown in destination information block 132. The destination data base memory card 120 may further include additional destination information relating to the corresponding destinations as shown in block 132. The additional destination information 132 may include the address of the particular destination, the phone number thereof and normal business hours, for example. It should be appreciated that the destination information 132 may encompass most any kind of numeric, alphabetic and symbolic text information that can be displayed on the display 30.

Detailed Description Paragraph Right (35):
Turning now to FIG. 10, the navigation menu selections and various selections within each menu selection are illustrated therein. With the use of the manually depressible navigation menu pushbutton 18, a user may select the navigation main menu. The

navigation main menu includes the memory card menu selection 134, the latitude/longitude position coordinates menu selection 136 and the save/recall menu selection 138. When entering the main menu, the first menu selection, namely the memory card menu selection 134, will be displayed. A user may depress the menu choices rotary pushbutton 16 to select the menu selection shown or rotate the the rotary pushbutton 16 to sequence to another menu selection. Once in the selected navigation menu selection, a user may rotate the menu choices rotary pushbutton switch 16 to scroll through the available categories, sub-categories and destinations within the menu selection.

Detailed Description Paragraph Right (36):
In the memory card menu selection 134, a user may rotate the menu choices rotary pushbutton 16 to scroll through the destination categories 124 and view category selections such as food, hotel and gas. To select a category selection such as food, the user manually depresses the rotary pushbutton 16 when viewing the food category. With the food category selected, the display 30 will show the first selection with sub-category 126. With the use of the menu choices rotary pushbutton 16, a user may sequence through each of the selections in sub-category 126 which may include fast food, fine dining, casual dining, etc. Similarly, the user may select a displayed fast food sub-category by manually depressing the menu choices rotary pushbutton switch 16. Thereafter, individual destination names 130 may be displayed on the display 30. Again, the user may sequence through a plurality of destination names 130 such as Burger Place or Burger Hut and select the currently displayed destination name by depressing the rotary menu choices pushbutton switch 16.

Detailed Description Paragraph Right (37):
When in the latitude/longitude position coordinate menu selection 136, a user may program in a set of latitude and longitude position coordinates to identify a selected destination. For each of the latitude and longitude coordinates this includes entering in degrees/minutes/seconds in a form such as 40.degree.30'29.2N, as an example. To enter coordinate information, the user easily rotates the menu choices rotary pushbutton switch 16 to sequence through alphanumeric characters which are sequentially displayed on display 30. When a desired alphanumeric character is displayed, the user may depress the rotary pushbutton switch 16 to select the displayed character. Continued rotary sequencing and depression of the rotary pushbutton switch 16 is repeated so as to sequentially select the next characters until the latitude and longitude position coordinates are entered in.

Detailed Description Paragraph Right (38):
In the save/recall menu selection 138, a user may select between the recall destination category 140 or the save destination category 142. The recall and save destination categories 140 and 142 allow access to a user programmable data base that may be stored in EEPROM 98 or RAM 94 or 96. This user programmable data base supplements the memory card data base and allows a user to modify and add to the overall available destinations. The navigation system 10B may advantageously share programmable memory with the audio entertainment system. For example, the user programmable memory dedicated to storing radio frequency selections can also be used to store user programmed destinations.

Detailed Description Paragraph Right (39):
To select either of recall or save categories 140 or 142, a user may toggle between the two categories 140 and 142 by rotating the menu choices rotary pushbutton switch 16 and depressing switch 16 to select the displayed category. When in the recall destination category 140, a user may sequence through a plurality of user stored destinations by rotating the rotary pushbutton switch 16 and depressing switch 16 to select the stored destination that is currently shown.

Detailed Description Paragraph Right (40):
In the save destination category 142, a user may select between a current destination name category 144 and a current "where I am" position category 146 by rotating menu choices rotary pushbutton switch 16 to the desired category and depressing menu choices switch 16 to make the selection. With the current destination name category 146, the currently selected destination from the memory card 120 may be saved in the user programmable data base. In the current "where I am" position category 146, the current position of the user is saved in the programmable memory. This allows a user

to save locations once visited and later recall the saved locations to obtain navigational assistance.

Detailed Description Paragraph Right (41):
Referring to FIG. 11, the methodology 174 of selecting among the various categories 124, sub-categories 126 and destinations 130 with the menu choices rotary pushbutton switch 16 is illustrated therein. The methodology 174 begins with the step 150 of selecting the memory card menu. With the memory card menu selected, a current category will be displayed 152. A user may either rotate the menu choices rotary pushbutton switch 16 to scroll through the available categories or may depress rotary pushbutton switch 16 to select the current category shown. According to step 154, if the current category shown is not selected, a user may rotate the menu choices rotary pushbutton switch 16 to the next category or categories as shown in step 156. If the user would like to select the current category, the user can depress the menu choices rotary pushbutton switch 16 to select the current category shown as provided in step 158.

Detailed Description Paragraph Right (43):
A user may sequence through as many categories and sub-categories as are necessary to select a desired destination from the destination data base. The number of sub-categories that are required to sequence through may vary. Accordingly, in step 168, the methodology 174 checks to see if the current selection is a destination. If the current selection is not a destination, the methodology 174 will return to step 160 to display the current sub-category. On the other hand, if the current selection is a destination, step 170 will display the destination name as well as the calculated distance and direction thereto.

Detailed Description Paragraph Right (44):
The menu choices rotary pushbutton control switch 16 may include the type having a grounded wiper rotatably moveable between a circular array of equi-angular space contacts in response to rotation of a control knob. A mechanical detent (not shown) on the switch 16 causes the wiper to prefer a position at each contact. Thus, the wiper "clicks" into contact at a predetermined degree of change of rotation of the position of the wiper. The term "click" is used herein to refer to the switch position changes between adjacent contacts. Clockwise rotation of rotary pushbutton control switch 16 advances to the next available selection, while a counter clockwise rotation returns to the previous available selection. According to a preferred embodiment, each rotational click switches to the next available selection. Alternately, a variable changing rate may be employed to more easily accommodate a large number of selections. That is, a user may scroll through the menu selections at a variable rate as a function of rate of change of rotation of the rotary pushbutton control switch 18. A rotary switch control which provides for such a variable rate is disclosed in U.S. patent application Ser. No. 08/179,300, filed Jan. 10, 1994, entitled "Variable Digital Control for Electronic Device with Rotary Switch Control". The present invention is assignable to the assignee of the aforementioned application.

Detailed Description Paragraph Right (45):
In addition to the menu choices rotary pushbutton control switch 16, a user may also select from the various other pushbutton navigation controls while operating and viewing the various menu selections and destination information. For example, a menu selection may be undone by depressing the undo pushbutton 22. This, in effect, undoes the last menu and returns the menu selection to the previous selection. Repeated depresses of undo pushbutton 22 sequentially back tracks through the previous selections until the main menu is reached.

Detailed Description Paragraph Right (46):
The sort by distance pushbutton 24, when depressed, will sort the destinations within a selected category or sub-category as a function of a calculated distance. With the sort by distance pushbutton 24 momentarily depressed, the navigation system 10 will sort all destinations within the selected category or sub-category by radial distance from the current position of the user. This is accomplished by comparing the latitude and longitude position coordinates of each destination within the selected category or sub-category with the current latitude and longitude position coordinates of the user. The sorted destinations are preferably arranged in order of increasing distance so that a user may first view the closest destination and thereafter rotate the menu choices rotary pushbutton 16 to view the next closest destination, if desired. It

should be appreciated that the sort by distance operation, according to one embodiment, provides a radial sort by distance which considers all destinations within a 360.degree. rotation, irrespective of their location relative to the vehicle's current direction of travel.

Detailed Description Paragraph Right (47):
With the sort by distance pushbutton 24 continually depressed for a predetermined amount of time, such as two seconds, a radial sort by distance from a selected destination may be performed. That is, instead of sorting destinations within selected categories or sub-categories from the current position of the user, a radial sort will be performed from a remote selected destination. For example, a user may perform a radial sort by distance from a selected hotel destination to determine the relative distances of available parking lots from the selected hotel. The radial sort by distance from a remote destination will provide an indication of the distance from the selected destination to each of the sorted destinations within the selected category and sub-categories.

Detailed Description Paragraph Right (48):
According to another embodiment, the sort by distance operation may be limited to sorting destinations by radial distance within a defined angular window centered about the vehicle's direction of travel. For example, all destinations within an angular field of view of forty-five degrees in front of the vehicle may be sorted radially and presented in increasing order to the user. This eliminates destinations which are located remote from the wayward course of travel. To implement a sort by distance with a limited field of view, a user may set the preferred sort mode via an additional options menu within the main menu.

Detailed Description Paragraph Right (49):
Once a destination has been selected, a user may access additional information pertaining to the selected destination. This is accomplished by depressing the information pushbutton 20. The information pushbutton 20 may be repeatedly depressed to scroll through successive displays of alphanumeric text information made available to the user. For example, the information pushbutton 20 may be depressed once to view the address information pertaining to the selected destination. The next successive depression of pushbutton 20 may display the phone number for the destination, while a third depression of pushbutton 20 may provide the normal business operating hours for the selected destination.

Detailed Description Paragraph Right (50):
As previously mentioned, the integrated navigation/audio entertainment system 10B may operate in an audio radio mode, a cassette tape mode and the navigation mode. Also, other modes of operation, such as a compact disc (CD) mode, may also be included. It should be understood that one of the audio cassette tapes or radio modes may be operating at the same time as the navigation system functions. In order to provide the proper display between the audio entertainment modes and the navigation modes, the navigation/audio entertainment system 10B is equipped with a radio display pushbutton 56 and a navigation display pushbutton 58. The radio display pushbutton 56 allows a user to view radio information on display 30 for a predetermined amount of time while operating in the navigation mode. According to one example, a time out period of five seconds may expire before returning to the navigation display mode. Alternately, the time out period may be infinite so as to eliminate the automatic return to the previous display mode. Similarly, the navigation display pushbutton 58 allows a user to display navigation information on display 30 when the system 10B is otherwise set in the audio entertainment mode. A time out period may likewise be used to automatically return to the audio entertainment display mode.

Detailed Description Paragraph Right (51):
The use of navigation system 10 for providing navigational services to reach a selected destination is illustrated in FIG. 12. As shown, a vehicle 110 equipped with the navigation system 10 of the present invention is shown at various locations while traveling on streets within a roadway system 176. Initially, vehicle 110 is shown providing distance and direction information with display 30 at a location 1.5 miles from a selected destination which is illustrated namely as hotel 172. As the vehicle 110 proceeds to travel along the roadway system 176, the straight-line distance and direction pointing arrow are continuously updated. The driver of the vehicle may use

the straight-line direction indication and distance information to assist in making decisions on how to reach the destination 172. It should be understood that the navigation system 10 does not require the driver of the vehicle 110 to steer the vehicle 110 in the direction of the direction pointing arrow. Instead, the driver of vehicle 110 must consider roadway restrictions and traveling requirements to determine the appropriate route of travel to destination 172.

Detailed Description Paragraph Right (52):
As the vehicle 110 approaches destination 172 to within a distance of 0.1 miles, the display 30 will display "nearby" and the navigation system 10 will sound an audible alarm signal. According to one embodiment, the audible alarm signal may be produced by audible tones. With the navigation/audio entertainment system 10B, the audible alarm may be produced with audible tones or output from audio speakers 65. If the vehicle 110 proceeds beyond the destination 172, the display 30 will return to displaying the current straight-line direction pointing arrow and distance from the current vehicle position to the destination 172.

Detailed Description Paragraph Right (53):
Referring now to FIG. 13, the methodology 180 of continuously determining the straight-line distance and direction to a selected destination is illustrated therein. The methodology 180 begins with the entering of the navigation mode as provided in step 182. The user may select the desired destination according to step 184. The navigation system 10 will then determine the most recent vehicle location and direction heading information as shown in step 186.

Detailed Description Paragraph Right (54):
To obtain the most recent vehicle location and direction heading information, the methodology 180 will check to see if the GPS solution is currently available pursuant to step 188. If the GPS solution is available, the current location is updated with the GPS data as provided in step 190. At the same time, the methodology 180 will continuously monitor vehicle speed to see if the vehicle speed is greater than a predefined speed of say five miles per hour, for example, as shown in step 192. Referring to step 194, if vehicle speed is greater than five miles per hour a new heading is derived from a GPS velocity value and the distance and direction information is computed according to step 200. If, however, the determined vehicle speed is not greater than five miles per hour, a new heading is derived from the current compass reading as provided in step 196 and the computed distance and direction information are calculated according to step 200.

Detailed Description Paragraph Right (55):
Should the GPS solution not be available as detected in test step 188, the new location is computed from the old location information with the addition of a dead reckoning system as shown in step 198. Currently, existing global positioning systems have been known to suffer from signal blockage caused by tall buildings and other interferences. When the GPS signal is unavailable, the present invention takes into account for any such interferences and enables the navigation system 10 to continue to operate despite the occurrence of GPS interference or other causes of unavailability of GPS. For example, in a typical urban environment, a vehicle may travel a roadway system between various tall buildings in which the GPS radio wave signals may be blocked by an obstruction caused by nearby buildings. This interference condition is known as the occurrence of GPS fade. In order to handle the GPS fade scenario, the navigation system 10 advantageously stores the last set of position coordinates and calculated speed and direction information, in addition to the time the last position coordinates were recorded. With the dead reckoning sensor information, given the vehicle speed sensor signal 76, the transmission position signal 78, compass reading 74 and time related information, the navigation board microprocessor 92 is able to determine an approximate expected location of the mobile user, despite the unavailability of GPS signals. Given the dead reckoning system information and calculations, the methodology 180 is able to derive the new direction heading from the current compass reading pursuant to step 196 and thereafter compute the straight-line distance and direction according to step 200.

Detailed Description Paragraph Right (56):
With the distance and direction computed, the methodology 180 will check to see if the user is near the destination to within a predefined distance of 0.1 mile, for example.

If the vehicle is within 0.1 miles of the destination, an audible alarm is sounded and the display displays "NEARBY" as shown in step 206. Otherwise, the display will provide an indication of the straight-line direction to the destination and the distance therebetween as shown in step 204. In any event, the methodology 180 will check for a new destination requested as shown in step 208 and then return to block 184.

Detailed Description Paragraph Right (57):
Referring now to FIGS. 14A through 14C, the sequencing of menu selections and displays are illustrated for selecting a destination and destination information from the destination data base stored in memory card 120. With particular reference to FIG. 14A, display block 210 illustrates the initial display 30 showing the navigation menu in capital letters on the top line of text and the selectable memory card menu in small case letters on the bottom line of text. Selection of the memory card menu advances to display block 212 where the geographic territory of coverage provided with the given memory card is illustrated by the description "ANYTOWN USA". Also shown on the bottom line of text is the first category, shown here as the "food" category selection.

Detailed Description Paragraph Right (58):
A destination category selection which a user may change or select is generally shown preceded by the addition of a carrot sign (>). Selection of the "food" category advances to display block 214 in which the first selection of a sub-category is shown as the "fast food" sub-category. Selection of the "fast food" sub-category with the menu choices rotary pushbutton 16 advances to display block 216. Within the "fast food" sub-category, a user may select one of several available destinations names such as "Burger Hut". An individual destination name is shown preceded by a filled carrot sign ().

Detailed Description Paragraph Right (59):
Once a destination has been selected, additional information may be displayed and explored. For example, given display block 216, the information pushbutton 20 may be depressed to display the updated straight-line distance and direction from the current position to the selected destination, namely Burger Hut, as shown in display block 218. Repeated depression of information pushbutton 20 will advance to display block 220 which displays the full descriptive name of the selected destination. Depression of information pushbutton 20 again will advance to display block 222 to display the address of the selected destination. Another depression of information pushbutton 20 will display the phone number for the selected destination as shown in display block 224.

Detailed Description Paragraph Right (60):
Referring again to display block 216, depression of menu choices rotary pushbutton 16 will advance to display block 226 to display the direction pointing arrow as well as the destination name and distance from the current position to the selected destination. In addition, the time of day may be displayed as shown. Repeated depressions of information pushbutton 20 will scroll through and display the text information that is available. For example, a first depression of information pushbutton 20 will display the destination name as provided in display block 228. Another depression of information pushbutton 20 will display the address of the destination as shown by display block 230, while a third depression of pushbutton 20 will display the phone number of the selected destination as shown in display block 232.

Detailed Description Paragraph Right (61):
Each time the information pushbutton 20 is depressed, information is retrieved and shown for a given block of information. Repeated depressions of information pushbutton 20 retrieve successive frames of information that are made available to the user. Each time the information pushbutton 20 is depressed, a timer is set to expire after a time period T.sub.0 equal to five seconds, for example. When the timer expires, the display will return to the last display shown prior to the initial operation of information pushbutton 20.

Detailed Description Paragraph Right (62):
Referring next to FIG. 14B, similar sequencing and displays are shown when selecting

one destination from a plurality memory card destinations which have the same name. As shown in FIG. 14B, the display blocks are substantially the same as those in FIG. 14A, except for the addition of display block 234 which identifies one of a plurality of fast food restaurants having identical names, herein shown as Burger Hut. In addition, display block 234 provides the address for the destination shown. It should be understood that a user may rotate menu choices rotary pushbutton switch 16 to sequence through the plurality of same name destinations and depress switch 16 to select the currently shown destination.

Detailed Description Paragraph Right (63):
In FIG. 14C, key sequences and displays are shown when selecting destinations sorted by radial distance from the current position of the user. The display blocks 210 through 224 and block 234 are substantially identical to those provided in FIG. 14B. However, at display block 234, a user depresses the "sort by distance" pushbutton 24 to advance to display block 236. The sort by distance operation will compare all destinations within the selected category and sub-categories by radial distance from the current position of the navigation system 10. The compared destinations are also sorted and arranged in order of increasing distance from the current position. For example, the sort by distance operation shown will sort all destinations within the sub-category entitled Burger Hut. This allows a user to easily view the closest destination first, and then sequence to the next closest destination, if desired.

Detailed Description Paragraph Right (64):
With the desired destination selected, a user may depress the information pushbutton 20 to advance to display block 238 which provides the descriptive name of the destination. Additional depressions of information pushbutton 20 will advance to display block 240 to provide the address and then to display block 242 to give the phone number of the destination. Returning to display block 236, depression of the menu choices rotary pushbutton switch 16 will advance to display block 244 to further illustrate the direction pointing arrow, destination name and calculated straight-line distance to the selected destination. Similarly, depression of information pushbutton 20 advances to display block 246 to provide the destination name, and further to display blocks 248 and 250 to provide the address and phone number, respectively.

Detailed Description Paragraph Right (65):
Turning now to FIG. 15, key sequences and displays are illustrated when entering a destination by the latitude and longitude position coordinates. In doing so, the navigation menu selection is performed with menu choices rotary pushbutton 16 to display the latitude/longitude menu selection as shown in display block 252. Depression of the menu choices rotary pushbutton 16 will select the latitude/longitude menu and advance to display block 254. In display block 254, the user is asked to enter a set of latitude position coordinates. The latitude position coordinates include degrees/minutes/seconds. To enter in the latitude coordinates, the menu choices rotary pushbutton 16 is rotated until a desired character is displayed. With the desired character displayed, a user may depress the rotary pushbutton 16 so as to select that character. The display will then move to the next character position so that the user may then enter in the next character and so on until the latitude position coordinates are entered as shown in display block 254.

Detailed Description Paragraph Right (66):
Once the latitude coordinates are entered, the user may depress the rotary pushbutton 16 again to advance to display block 256. In display block 256, the user is asked to enter a set of longitude position coordinates by entering degrees/minutes/seconds. A user will rotate the menu choices rotary pushbutton 16 to select and choose the longitude position coordinates as shown in display block 256. Once the longitude and latitude position coordinates are entered, the information pushbutton 20 may be depressed to toggle between the user entered latitude and longitude position coordinates as shown in display blocks 256 and 258. If the latitude and longitude coordinates are correct, the user may depress rotary pushbutton 16 to advance to display block 260.

Detailed Description Paragraph Right (67):
As shown in display block 260, the longitude and latitude position coordinates as entered may be saved in the user programmable memory location. As shown, however, the entered position coordinates shown are not saved and the display advances to display

block 262 in which the latitude and longitude position coordinates are displayed as well as the direction pointing arrow and the straight-line distance and time of day. Depression of information pushbutton 20 will advance to block 264 which shows the latitude coordinates on the top line and the longitude coordinates on the bottom line. Additional depressions of information pushbutton 20 will advance to display blocks 266 and 268 which show latitude and longitude positions coordinates titled by name.

Detailed Description Paragraph Right (68):
Referring now to the save/recall menu operation, key sequences and displays are shown in FIGS. 16A through 16E for illustrative purposes. Referring to FIG. 16A, the key sequences and displays are shown when saving the current "where I am" user position as a destination. Beginning with display block 270, the navigation menu shows selection of the save/recall menu. Depression of menu choices rotary pushbutton 16 advances to display block 272 which displays the save destination category. Selection of the save destination category advances to display block 274 where the user may select the "where I am" selection for saving the current position in the user programmable memory. To check the current position, a user may depress information pushbutton 20 to view the current latitude position coordinates in display block 276 and the current longitude position coordinates in display block 278.

Detailed Description Paragraph Right (69):
To save the current position coordinates, the menu choices rotary pushbutton 16 is depressed to advance to display block 280. In display block 280, the user may select which programmable memory location to use to store the current position as a user selectable destination. By depressing information pushbutton 20, the user may display information pertaining to the old destination stored in a currently shown memory location. For example, display blocks 282, 284 and 286 may be viewed so a user may determine whether to copy the current position over the old location information. Alternately, information pertaining to old coordinates as shown in display blocks 288, 290 and 292 may be viewed.

Detailed Description Paragraph Right (70):
Once a user selects the desired memory location, a descriptive name may be entered to indentify the current position being saved. Verification of the stored name is provided in display block 296 and the navigation system 10 returns to the last navigation mode.

Detailed Description Paragraph Right (71):
Key sequencing and displays for storing a user selected destination as the last entry is illustrated in FIG. 16B. The save/recall menu selection and save destination categories are selected as shown in display blocks 270 and 272. Referring to display block 298, a user may select to save the last entered destination, shown here as "Burger Hut". Depression of information pushbutton 20 provides additional information as shown in display blocks 300, 302 and 304.

Detailed Description Paragraph Right (72):
To save the last entered destination, menu choices rotary pushbutton 16 is depressed to advance to display block 280 to select the user programmable memory location in which to save the last destination entry. Similarly, information pertaining to an old entry for a currently shown memory location may be viewed by depressing the information pushbutton 20 to proceed to display blocks 282 through 292. The desired memory location is selected and the current destination last entered is saved in the corresponding memory location as shown in display block 306. The navigation system 10 thereafter returns to the last mode.

Detailed Description Paragraph Right (73):
Key sequences and displays are shown in FIG. 16C when storing a user destination last entered by latitude and longitude position coordinates. The save/recall menu and save destination category are selected as shown by display blocks 270 and 272. With the save category selected, the last entered destination may be saved with the latitude and longitude position coordinates as shown in display block 308. The latitude and longitude position coordinates for the last entered destination may be viewed as shown in display blocks 310, 312 and 314. To save the current latitude and longitude position coordinates, the menu choices rotary pushbutton 16 is depressed to advance to the display block 280 and destination storage in a user programmable memory location

is achieved as described in connection with FIGS. 16A and 16B.

Detailed Description Paragraph Right (74):
Referring to FIGS. 16D and 16E, key sequences and displays are shown for recalling user stored destinations. In FIG. 16D, user stored destinations are recalled from the user programmable memory locations which were previously stored from the destination data base in the memory card. With the save/recall menu selected in block 270, the recall destination category 140 is selected as shown in display block 316. The recall destination category allows for sequencing through a predetermined number of available memory locations. By rotating the menu choices rotary pushbutton 16, user may view destination names given to the individual memory locations. Within each destination name, additional destination information may be viewed by depressing the information pushbutton 20 as shown in display blocks 320, 322, 324 and 326. Once a particular memory location is selected, the destination name, direction pointing arrow to the destination and distance to the destination is shown on display 30 as provided by display block 328. Information pushbutton allows for viewing of additional information corresponding to the selected destination and as provided in display blocks 330, 332 and 334.

Detailed Description Paragraph Right (75):
Finally, referring to FIG. 16E, stored destinations which were previously stored as latitude and longitude position coordinates are now recalled under the recall destination category. Recalling the desired destination is achieved in a manner similar to that described in connection with 16D. However, the information provided with regard to each of the selectable destinations provides the latitude and longitude position coordinates as shown in display blocks 336, 338, 340 and also in display blocks 342, 344 and 346.

Detailed Description Paragraph Right (76):
It should be understood that the navigation system 10 of the present invention advantageously provides low cost and easy to use navigation services for assisting a user in reaching a desired destination. The navigation system 10 is a tool for assisting a user to reach a destination, while allowing a user to independently make decisions on the appropriate route to reach the destination. While the navigation system 10 is described in connection with an automotive vehicle for assisting the driver thereof, it should be understood that the navigation system 10 is applicable for a wide variety of applications which generally require travel to reach a desired destination.

CLAIMS:

1. An integrated navigation/audio entertainment system for use in a vehicle, said system comprising:

an audio entertainment unit including audio electronics for producing audio signals;

a position sensing receiver for receiving signals containing position information and determining a current position thereof;

a destination database containing a plurality of selectable destinations and destination position coordinates;

user selectable input means for selecting at least one of said destinations; processor means for determining a distance and a direction from the determined current position to the selected destination;

a housing substantially enclosing at least the audio entertainment unit and said processor means, said housing being adapted to be located in a vehicle; and

a mapless display for providing a visual indication of the determined distance and the direction to the selected destination when in a navigation display mode and for displaying audio entertainment information when in an audio display mode.

5. The system as defined in claim 4 further comprising a head up imaging display for projecting an image of the distance and the direction in front of a driver of the

vehicle.

6. The system as defined in claim 1 wherein said destination database comprises a readable memory card.

7. The system as defined in claim 6 wherein said database further comprises text information pertaining to each of the destinations on the memory card.

8. The system as defined in claim 1 wherein said audio display mode may include any one of a radio, cassette tape player and CD player.

9. An integrated navigation/audio entertainment system comprising;

an audio radio including a tuner and radio controller for producing audio signals; a position sensing receiver for receiving GPS position signals and determining a current position thereof;

a destination database containing a plurality of selectable destinations and destination position coordinates;

a user selectable input means for selecting at least one of said destinations;

processor means for determining a distance and a direction from the determined current position to the selected destination;

a housing substantially enclosing at least said audio radio and said processor means, said housing being adapted to be located in a vehicle; and

a mapless display for providing a visual indication of the direction and distance to the selected destination and distance information when in a navigation display mode and for displaying audio entertainment information when in an audio display mode.

11. A navigation system substantially integrated with an audio entertainment system and sharing a common housing and at least some common electronic components, said navigation system comprising:

a position sensing receiver for receiving GPS signals containing position information and determining a current position thereof;

a destination database containing a plurality of selectable destinations and destination position coordinates;

a user selectable input means for selecting at least one desired destination;

processor means for determining a distance and a direction from the determined position to the selected destination, wherein said processor means is enclosed within the common housing and said housing is adapted to be mounted in a vehicle; and

a mapless display for displaying a visual indication of the distance and the direction to the selected destination when in a navigation display mode and for displaying audio entertainment information when in an audio display mode.

12. The navigation system as defined in claim 11 wherein said audio entertainment system comprises a car radio for mounting in an automotive vehicle.

13. The navigation system as defined in claim 11 wherein said mapless display includes an alphanumeric display for displaying alphanumeric characters and a straight line direction pointing indicator.

14. In an automotive audio radio having a housing adapted to be mounted in a vehicle and enclosing a tuner and radio controller and further having a simplistic and inexpensive radio display, a navigation system substantially integrated within the housing and comprising:

a position sensing receiver for receiving GPS signals containing position information

and determining a current position thereof;

a destination database containing a plurality of selectable destinations and destination position coordinates;

a user selectable input for selecting at least one desired destination;

a processor for determining a distance and a direction from the determined position to the selected destination; and

a mapless direction pointing arrow display for providing a visual indication of the direction to the selected destination, said radio display displaying the distance to the selected destination when in a navigation display mode and displaying audio radio information when in an audio display mode.

15. The navigation system as defined in claim 14 wherein said radio display comprises a mapless alphanumeric display for displaying alphanumeric characters.

16. The navigation system as defined in claim 14 wherein said destination database includes a memory card reader for reading destination information from a memory card.

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DOCUMENT-IDENTIFIER: US 5732385 A
TITLE: Vehicle navigation system displaying bird-eye view of different visual points and different contraction scale ratios depending upon vehicle travel conditions

Abstract Paragraph Left (1):
A vehicle navigation system includes: a key board (9) for setting a start point and a destination of a vehicle; a speed sensor (2) for detecting vehicle travel speed; an azimuth sensor (1) for detecting travel direction; a road map data memory (3) for storing road map data related to various roads; a display unit (8); and CPU (4) provided with functions for detecting a current vehicle position (CVP) on the basis of the detected speed and direction after the start point and in accordance with road map data; calculating a recommendable route from the start point to the destination on the basis of the road map data; and forming various birds-eye view road maps. In particular, the birds-eye view road maps of different visual points (E) and different contraction scale ratios can be formed according to vehicle travel speed or according to a distance from the current vehicle position to the nearest specific traffic point (e.g., intersection); that is, various birds-eye view road maps obtained from a suitable visual point and in a suitable contraction scale ratio can be displayed at all times according to the vehicle travel conditions.

Brief Summary Paragraph Right (2):
The present invention relates to a vehicle navigation system or a vehicle route guiding system for displaying a road map in the vicinity of the current vehicle position to guide the vehicle along the displayed road map, and more specifically to a vehicle navigation system which can is change the contraction scale ratio of the displayed road map according to various vehicle travel conditions.

Brief Summary Paragraph Right (4):
A vehicle navigation system for calculating a recommendable vehicle travel route from a start position to a destination and for displaying the road map in the vicinity of the current vehicle position to guide the vehicle along the recommendable route is well known. In the conventional vehicle navigation system, the displayed road map is exchanged with a new one whenever the vehicle travels by a predetermined distance, so that the current vehicle position can be always displayed on the road map. However, since the number of road maps replaced with new one per unit time increases with increasing vehicle travel speed, when the vehicle travel speed is high, the road maps are exchanged frequently, with the result that the driver cannot see well or confirm securely various road information displayed on the display unit together with the road map.

Brief Summary Paragraph Right (5):
To overcome this problem, Japanese Published Unexamined (Kokai) Patent Application No. 2-130412 discloses such a vehicle navigation system that the contraction scale ratio of the road maps is kept always constant and only the road information is changed according to the vehicle travel speed, for instance in such a way that only the important road information of express highways or major national roads is displayed when the vehicle travels at high speed.

Brief Summary Paragraph Right (6):
In addition, there has been proposed such a vehicle navigation system that the contraction scale ratios of the road maps can be selected with a switch. However, this method is troublesome, because the contraction scale ratio must be selected by the

driver with the use of the switch.

Brief Summary Paragraph Right (7):
Further, Japanese Published Unexamined Patent Application No. 2-61690 discloses a superimposed method such that two road maps of large and small contraction scale ratios are displayed simultaneously on the same display unit. In this method, the vicinity of the current vehicle position is displayed in a relatively large contraction scale ratio and positions far away from the current vehicle position is displayed in a relatively small contraction scale ratio.

Brief Summary Paragraph Right (8):
In an example shown in FIG. 1, only a nearest intersection from the current vehicle position along the vehicle travel direction is enlarged and displayed on the upper right side of the rod map. In this guiding system, there exists such an advantage that the driver can see an enlarged road map near the current vehicle position and in addition he can know the road situation near the current vehicle position in detail. In this guiding system, however, since an enlarged road map is displayed on the upper right corner on the display unit, the original road map is not displayed completely, thus resulting in a problem in that when the driver will turn to the right for instance, it is impossible to confirm the road situation ahead on the right side along the vehicle travel direction.

Brief Summary Paragraph Right (9):
To overcome this problem, there exists a method of displaying the road map in the form of an birds-eye view. In this birds-eye view, the road map is displayed as if seen from the sky obliquely downward, which is well known in the field of the flight simulator.

Brief Summary Paragraph Right (10):
This birds-eye view will be explained in further detail with reference to FIG. 2, in which the topography (ground) lies in an XY plane, and a visual point E (x, y, z) is determined on a Z axis perpendicular to the XY plane. A rectangle abcd is a range actually displayed on the display unit, and a road map range seen from the visual point E through the rectangle abcd is a broad ground range ABCD. In other words, in the birds-eye view it is possible to see road map data lying in the rectangle ABCD much broader than the displayed rectangle abcd.

Brief Summary Paragraph Right (11):
In this method, since an image can be displayed as if a broad trapezoidal range ABCD were seen from a visual point E, this method is referred to as an birds-eye (air or bird's eye) view display method. In this birds-eye view display method, there exists such an advantage that a center f of the rectangle abcd representative of the displayed range corresponds to a position F in the trapezoid ABCD and further this point F is located near the side AB rather than the side CD of the trapezoid ABCD. Accordingly, the range from the side AB to the point F can be displayed in the lower half of the display unit. Further, since the side AB is shorter than the side CD, the side AB can be displayed as an enlarged view.

Brief Summary Paragraph Right (12):
FIG. 3B shows an example of the birds-eye view, in which a recommendable vehicle travel route from a start position to a destination is shown together with the vicinity thereof the current vehicle position CVP in the birds-eye view method. In this example, the visual point is set in the sky opposite to the destination (behind the current vehicle position), and the ground (topography) is seen from above in the vehicle travel direction. Further, the current vehicle travel position CVP is also shown in the birds-eye view road map as an arrow. In such a displayed image as described above, the map contraction scale ratio increases continuously with increasing distance from the current vehicle position; in other words, the vicinity of the current vehicle position can be enlarged and further the recommendable route can be displayed far to the destination.

Brief Summary Paragraph Right (13):
On the other hand, FIG. 3A shows an example of the usual display, in which the current vehicle position CVP is indicated on roughly the same position on the map as that shown in FIG. 3B. In FIG. 3A, although the current vehicle position CVP and the

vicinity thereof can be displayed in an enlarged scale, the recommendable route is displayed only at a short distance.

Brief Summary Paragraph Right (14):
In the above-mentioned vehicle navigation system with the use of the road maps of birds-eye view, the ground range to be displayed on the display unit is largely dependent upon the location of the visual point and the visual direction (the vertical overlook angle to the ground and the horizontal visual line direction. In other words, when the visual point and the visual direction are not correct, the satisfactory display range required for the driver cannot be displayed. Accordingly, if only the visual point is set so that the current vehicle position can be displayed on the display unit, when the visual direction is not determined correctly, it is impossible to sufficiently display the ground from the current vehicle position to the destination.

Brief Summary Paragraph Right (15):
On the other hand, when the vehicle travels at high speed, the driver wishes to see a point far from the current vehicle position on the road map. On the other hand, when the vehicle travels at low speed, the driver wishes to see a point near the current vehicle position on the same road map in detail. In the conventional vehicle navigation system, however, since the contraction scale ratio cannot be adjusted automatically according to the vehicle speed, the driver must select the appropriate contraction scale ratio with a switch, thus causing a troublesome operation.

Brief Summary Paragraph Right (16):
On the other hand, there exists such a tendency that the driver can see and recognize well the road map near the current position, when the recommendable vehicle travel direction is shown vertically on the display unit; that is, when the current travel road is displayed in the vertical direction on the central upper side of the display unit (without displaying the current travel road on the right or left side thereof obliquely). In particular, in the case where the vehicle approaches a traffic position at which the vehicle tends to travel erroneously away from the recommendable route (e.g., intersections of a plurality of roads), it is preferable that the travel direction toward the intersections is displayed in the vertical direction on the display unit, as shown in FIG. 4B, rather than displayed as shown in FIG. 4A.

Brief Summary Paragraph Right (18):
With these problems in mind, therefore, it is the object of the present invention to provide a vehicle navigation system which can control the visual point and the contraction scale ratio of the displayed road maps of birds-eye view according to the vehicle travel speed.

Brief Summary Paragraph Right (19):
Further, the other object of the present invention is to provide a vehicle navigation system which can display the road map of birds-eye view in such a way the visual point and/or the visual direction for birds-eye view can be adjusted according to the distance between the current vehicle position and the nearest intersection to be guided, so that the driver can well see the road map and thereby can be well guided in accordance with the road map.

Brief Summary Paragraph Right (20):
To achieve the above-mentioned object, the present invention provides a vehicle navigation system, comprising: vehicle position setting means (9) for setting a start point and a destination of a vehicle; vehicle speed sensing means (2) for detecting vehicle travel speed; vehicle travel azimuth detecting means (1) for detecting vehicle travel direction; road map data storing means (3) for storing road map data related to various roads; vehicle position detecting means (4A) for detecting a current vehicle position (CVP) on the basis of the detected vehicle speed and travel direction after the start point and in accordance with road map data; recommendable route calculating means (4B) for calculating a recommendable route from the start point to the destination on the basis of the road map data; birds-eye view forming means (4E) for forming various birds-eye view road maps of different visual points (E) and different contraction scale ratios according to vehicle travel conditions; and display means (8) for displaying the formed birds-eye view road map.

Brief Summary Paragraph Right (21):
Further, the first aspect of the present invention provides a vehicle navigation system, comprising: vehicle position setting means (9) for setting a start point and a destination of a vehicle; vehicle speed sensing means (2) for detecting vehicle travel speed; vehicle travel azimuth detecting means (1) for detecting vehicle travel direction; road map data storing means (3) for storing road map data related to various roads; vehicle position detecting means (4A) for detecting a current vehicle position (CVP) on the basis of the detected vehicle speed and travel direction after the start point and in accordance with road map data; recommendable route calculating means (4B) for calculating a recommendable route from the start point to the destination on the basis of the road map data; birds-eye view forming means (4E) for forming an birds-eye view road map taken from a visual point (E) located in the sky behind the current vehicle position; the visual point (E) being determined on the basis of a visual line end position (F), a visual line length (.vertline.EF.vertline.), a vertical overlook angle (.theta.), and a horizontal visual line direction angle (.phi.) according to the detected travel speed; and display means (8) for displaying the formed birds-eye view road map.

Brief Summary Paragraph Right (22):
Further, the birds-eye view forming means sets the visual line end position (F) near the current vehicle position so that the detected current vehicle position (CVP) can be displayed substantially at the same position on the display means, irrespective of the vehicle travel speed.

Brief Summary Paragraph Right (26):
Further, the birds-eye view forming means sets the horizontal visual line direction (.phi.) to a vehicle travel direction detected by said azimuth detecting means. The birds-eye view forming means sets the horizontal visual line direction (.phi.) to a direction in which the calculated recommendable route can be display over the longest distance on the display means. The birds-eye view forming means sets the horizontal visual line direction (.phi.) to a direction of the destination.

Brief Summary Paragraph Right (27):
Further, the second aspect of the present invention provides a vehicle navigation system, comprising: vehicle position setting means (9) for setting a start point and a destination of a vehicle; vehicle speed sensing means (2) for detecting vehicle travel speed; vehicle travel azimuth detecting means (1) for detecting vehicle travel direction; road map data storing means (3) for storing road map data related to various roads; vehicle position detecting means (4A) for detecting a current vehicle position (CVP) on the basis of the detected vehicle speed and travel direction after the start point and in accordance with road map data; recommendable route calculating means (4B) for calculating a recommendable route from the start point to the destination on the basis of the road map data; specific point extracting means (4C) for extracting specific traffic points for the vehicle to be guided from the calculated recommendable route; distance comparing means (4D) for comparing a distance (d) between the current vehicle position and one of the extracted specific traffic points with a predetermined value (D); birds-eye view forming means (4E) for forming an birds-eye view road map taken from a visual point (E) located in the sky behind the current vehicle position; the visual point (E) being determined on the basis of a visual line end position (F), a visual line length (.vertline.EF.vertline.), a vertical overlook angle (.theta.), and a horizontal visual line direction angle (.phi.) according to a distance (d) between the current vehicle position and one of the extracted specific traffic points; and display means (8) for displaying the formed birds-eye view road map.

Brief Summary Paragraph Right (29):
Further, the birds-eye view forming means sets the visual line end position (F) to the nearest guide intersection, to display the nearest guide intersection substantially vertically on the display means, when the compared distance (d) to the nearest guide intersection is shorter than the predetermined value (D); but to a point a predetermined distance ahead from the current vehicle position along the recommendable route, to display the recommendable route substantially vertically on the display means, when the compared distance (d) to the nearest guide intersection is longer than the predetermined value (D).

Brief Summary Paragraph Right (30):
Further, the birds-eye view forming means sets the visual line end position (F) to a point in the vehicle travel direction, to display the vehicle travel direction substantially vertically on the display means, when the compared distance (d) to the nearest guide intersection is shorter than the predetermined value (D); but to a point a predetermined distance ahead from the current vehicle position along the recommendable route, to display the recommendable route substantially vertically on the display means, when the compared distance (d) to the nearest guide intersection is longer than the predetermined value (D).

Brief Summary Paragraph Right (32):
Further, the birds-eye view forming means sets the visual point (E) to a lower point (E1) near behind away from the current vehicle position (CVP) when the compared distance (d) to the nearest guide intersection is shorter than the predetermined value (D), but to a higher point (E2) far behind away form the current vehicle position when the compared distance to the nearest guide intersection is longer than the predetermined value, while keeping the vertical overlook angle (.theta.) at a constant value irrespective of the distance between the two; said birds-eye view forming means further setting the visual line end position (F) to a line between the current vehicle position and the nearest guide intersection to display the nearest guide intersection substantially vertically on the display means, irrespective of the distance between the two.

Brief Summary Paragraph Right (33):
Further, the birds-eye view forming means sets the visual point (E) to a higher point (E4) near behind away from the current vehicle position (CVP) when the compared distance (d) to the nearest guide intersection is shorter than the predetermined value (D), but to a lower point (E3) far behind away form the current vehicle position when the compared distance to the nearest guide intersection is longer than the predetermined value, while keeping a distance (EF) between the visual point (E) and the current vehicle position (CVP) at a constant value irrespective of the distance between the two; said birds-eye view forming means further setting the visual line end position (F) to a line between the current vehicle position and the nearest guide intersection or an extension line thereof to display the nearest guide intersection substantially vertically on the display means, irrespective of the distance between the two.

Brief Summary Paragraph Right (34):
Further, the first aspect of the present invention provides a method of guiding an automotive vehicle, comprising the steps of: setting a start point and a destination of a vehicle; detecting vehicle travel speed; detecting vehicle travel direction; storing road map data related to various roads; detecting a current vehicle position (CVP) on the basis of the detected vehicle speed and travel direction after the start point in accordance with road map data; calculating a recommendable route from the start point to the destination on the basis of the road map data; forming an birds-eye view road map taken from a visual point (E) located in the sky behind the current vehicle position, by changing the visual point (E) determined on the basis of a visual line end position (F), a visual line length (.vertline.EF.vertline.), a vertical overlook angle (.theta.), and a horizontal visual line direction angle (.phi.), according to the detected travel speed; calculating a road range to be displayed; reading road map data from the stored road map data; transforming the road map data into birds-eye view road map data; storing the transformed birds-eye view road map data; displaying the formed and stored birds-eye view road map; and updating the birds-eye view road map for each predetermined vehicle travel distance.

Brief Summary Paragraph Right (35):
Further, the step of forming the birds-eye view road map comprises the steps of: setting the visual line end position (F) at the current vehicle position (CVP); setting the vertical visual line direction angle (.phi.); calculating a visual line direction length .vertline.EF.vertline. in accordance with a formula as .vertline.EF.vertline.=k1+k2+vehicle speed, where k1 and k2 are a constant, respectively; and calculating the visual point (E) on the basis of the set visual line end position (F), the set vertical visual line direction angle (.phi.), and the calculated visual line direction length (.vertline.EF.vertline.), while keeping the vertical overlook angle (.theta.) at a constant value.

Brief Summary Paragraph Right (36):
Further, the step of forming the birds-eye view road map comprises the steps of: setting the visual line end position (F) at the current vehicle position (CVP); setting the visual line direction angle (.phi.); calculating the vertical overlook angle .theta. at the current vehicle position in accordance with a formula as .theta.=k3+k4.times.vehicle speed, where k3 and k4 are a constant, respectively; and calculating the visual point (E) on the basis of the set visual line end position (F), the set vertical visual line direction angle (.phi.), and the calculated vertical overlook angle (.theta.), while keeping the visual line length (.vertline.EF.vertline.) at a constant value.

Brief Summary Paragraph Right (37):
Further, the second aspect of the present invention provides a method of guiding an automotive vehicle, comprising the steps of: setting a start point and a destination of a vehicle; detecting vehicle travel speed; detecting vehicle travel direction; storing road map data related to various roads; detecting a current vehicle position (CVP) on the basis of the detected vehicle speed and travel direction after the start point in accordance with road map data; calculating a recommendable route from the start point to the destination on the basis of the road map data; detecting whether the vehicle has passed through an intersection; if has passed the intersection, reading a nearest intersection from the stored road map data; if not passed through the intersection, calculating a distance d from the current vehicle position to the nearest intersection; forming an birds-eye view road map taken from a visual point (E) located in the sky behind the current vehicle position, by changing the visual point (E) determined on the basis of a visual line end position (F), a visual line length (.vertline.EF.vertline.), a vertical overlook angle (.theta.), and a horizontal visual line direction angle (.phi.), according to the calculated distance d to the nearest intersection; calculating a road range to be displayed; reading road map data from the stored road map data; transforming the road map data into birds-eye view road map data; storing the transformed birds-eye view road map data; displaying the formed and stored birds-eye view road map; and updating the birds-eye view road map for each predetermined vehicle travel distance.

Brief Summary Paragraph Right (38):
Further, the step of forming the birds-eye view road map comprises the steps of: if the calculated distance d is shorter than the predetermined distance D, setting the visual point (E) behind the current vehicle position and further setting the visual line end position (F) to the nearest intersection; and if the calculated distance d is longer than the predetermined distance D, setting a visual point (E) behind the current vehicle position and further setting the visual line end position (F) to a point a predetermined distance ahead from the current vehicle position along the recommendable route.

Brief Summary Paragraph Right (39):
Further, the step of forming the birds-eye view road map comprises the steps of: if the calculated distance d is shorter than the predetermined distance D, setting the visual point (E) behind the current vehicle position and further setting the visual line end position (F) to a point along a vehicle travel direction; and if the calculated distance d is longer than the predetermined distance D, setting the visual point (E) behind the current vehicle position and further setting the visual line end position (F) to a point a predetermined distance ahead from the current vehicle position along the recommendable route.

Brief Summary Paragraph Right (40):
Further, the step of forming the birds-eye view road map comprises the steps of: calculating a vertical overlook limit angle .alpha. in accordance with a formula as .alpha.=k.times.d/D+c where k and D denote a constant, respectively; selecting vertical overlook angles (.theta.i) within the calculated vertical overlook limit angle (.alpha.); forming birds-eye view road maps at the selected vertical overlook angles (.theta.i); selecting one of the vertical overlook angles (.theta.i) at which the recommendable route can be displayed over the longest distance; forming an birds-eye view road map by changing the visual point (E) on the basis of the selected vertical overlook angle (.theta.).

Brief Summary Paragraph Right (41):
Further, the step of forming the birds-eye view road map comprises the steps of: if the calculated distance d is shorter than the predetermined distance D, calculating a distance L between the visual point (E) and the current vehicle position (CVP) in accordance with a formula as L=j1.times.d+j2 where j1 and j2 denote a constant, respectively; if the calculated distance d is longer than the predetermined distance D, setting the distance L to a fixed value L0; setting the visual line end position (F) to a line between the current vehicle position and the nearest intersection; and forming an birds-eye view road map taken from a visual point (E), by changing the visual point (E) on the basis of the calculated distance L between the visual point (E) and the current vehicle position (CVP), and the set visual line end position (F), while keeping the vertical overlook angle (.theta.) at a constant value.

Brief Summary Paragraph Right (42):
Further, the step of forming the birds-eye view road map comprises the steps of: if the calculated distance d is shorter than the predetermined distance D, calculating the vertical overlook angle .theta. in accordance with a formula as .theta.=k5-k6.times.d where k5 and k6 denote a constant, respectively; if the calculated distance d is longer than the predetermined distance D, setting the vertical overlook angle .theta. to a fixed value .theta.0; setting the visual line end position (F) to a line between the current vehicle position and the nearest intersection or an extension line thereof; and forming an birds-eye view road map taken from a visual point (E), by changing the visual point (E) on the basis of the calculated vertical overlook angle (.theta.) and the set visual line end position (F), while keeping the visual line length (.vertline.EF.vertline.) at a constant value.

Brief Summary Paragraph Right (43):
As described above, in the vehicle navigation system according to the present invention, since the birds-eye view road maps of various visual points and various contraction scale ratios can be displayed appropriately according to the vehicle speed or the distance between the current vehicle position and a specific traffic point (e.g., the nearest intersection), the driver can see the road map under the best conditions at all times.

Drawing Description Paragraph Right (1):
FIG. 1 is a view showing an example of usual road maps of the conventional vehicle guiding system;

Drawing Description Paragraph Right (2):
FIG. 2 is a view for assistance in explaining the birds-eye view display method;

Drawing Description Paragraph Right (3):
FIG. 3A is a view showing an example of usual road maps, which displays a recommendable route and the vicinity thereof;

Drawing Description Paragraph Right (4):
FIG. 3B is a view showing an example of birds-eye view road maps, which displays a recommendable route and the vicinity thereof;

Drawing Description Paragraph Right (5):
FIG. 4A is a view showing an example of an intersection displayed on the display unit;

Drawing Description Paragraph Right (6):
FIG. 4B is a view showing another preferable example of an intersection displayed on the display unit;

Drawing Description Paragraph Right (7):
FIG. 5A is a block diagram showing a basic embodiment of the vehicle navigation system according to the present invention;

Drawing Description Paragraph Right (8):
FIG. 5B is a block diagram showing another basic embodiment (in which the CPU functions are shown) of the vehicle navigation system according to the present invention;

Drawing Description Paragraph Right (9):
FIG. 6 is a flowchart showing a basic procedure for forming an birds-eye view in the vehicle navigation system according to the present invention;

Drawing Description Paragraph Right (11):
FIG. 8 is a flowchart showing a more detailed procedure of the step S4 shown in FIG. 6, for explaining a first embodiment of a first aspect of the navigation system according to the present invention;

Drawing Description Paragraph Right (12):
FIG. 9 is a view for assistance in explaining the movement of the visual point and the visual line direction of the birds-eye view road map of the first embodiment;

Drawing Description Paragraph Right (13):
FIGS. 10A and 10B are views for assistance in explaining the relationship between the visual point and the display position (visual field angle);

Drawing Description Paragraph Right (15):
FIG. 12 is a flowchart showing a more detailed procedure of the step S4 shown in FIG. 6, for explaining a second embodiment of the first aspect of the navigation system according to the present invention;

Drawing Description Paragraph Right (16):
FIG. 13 is a view for assistance in explaining the movement of the visual point and the visual line direction of the birds-eye view road map of the second embodiment;

Drawing Description Paragraph Right (18):
FIG. 15 is a flowchart showing a procedure of a first embodiment of a second aspect of the vehicle navigation system according to the present invention;

Drawing Description Paragraph Right (19):
FIG. 16A is a view showing an example of birds-eye view road maps obtained when the distance to the next guide intersection is short;

Drawing Description Paragraph Right (20):
FIG. 16B is a view showing an example of birds-eye view road maps obtained when the distance to the next guide intersection is long;

Drawing Description Paragraph Right (21):
FIG. 17 is a flowchart showing a procedure of a second embodiment of the second aspect of the vehicle navigation system according to the present invention;

Drawing Description Paragraph Right (22):
FIG. 18 is a flowchart showing a procedure of a third embodiment of the second aspect of the vehicle navigation system according to the present invention;

Drawing Description Paragraph Right (23):
FIG. 19 is a flowchart showing a procedure of a fourth embodiment of the second aspect of the vehicle navigation system according to the present invention; and

Drawing Description Paragraph Right (24):
FIG. 20 is a flowchart showing a procedure of a fifth embodiment of the second aspect of the vehicle navigation system according to the present invention.

Detailed Description Paragraph Right (1):
Embodiments of the vehicle navigation system according to the present invention will be described hereinbelow with reference to the attached drawings.

Detailed Description Paragraph Right (2):
FIG. 5A is a basic block diagram showing the vehicle navigation system according to the present invention, and FIG. 5B is a similar basic block diagram showing the functions of the CPU shown in FIG. 5A in detail. In FIG. 5A, the system comprises an azimuth sensor (vehicle travel azimuth detecting means) 1 for detecting a vehicle travel direction from the north or the south; a vehicle speed sensor (vehicle speed

sensing means) 2 for detecting vehicle travel speed (e.g., mounted on a transmission to output a predetermined number of pulse signals according to vehicle speed); a road map data memory (road map data storing means) 3 for storing various road map data together with various road network data (e.g., node position information indicative of intersections or curved points, etc., or character information such as route distances of link roads between two nodes, place names, etc.); a CPU 4 for executing various processing in accordance with control programs; a ROM 5 for storing the control programs executed by the CPU 4; a RAM 6 for storing calculation results of the CPU 4; a V-RAM 7 for storing birds-eye view display data formed by the CPU 4 and display as pictographic information; a display unit (display means) 8 for displaying stored birds-eye view road map data; an operation key board (vehicle position setting means) 9 for setting various data such as a start point, a destination, etc.; a GPS (ground position satellite) receiver 10 for receiving GPS signals transmitted by a GPS satellite; and an interface (I/F) circuit 11 for transferring various signals to and from the above-mentioned elements 1 to 10.

Detailed Description Paragraph Right (3):
Further, as shown in FIG. 5B, the CPU is provided with such functions as vehicle position determining means 4A; recommendable vehicle travel route calculating means 4B; a specific traffic point (e.g., a nearest intersection along the recommendable route) extracting means 4C; distance comparing means 4D for comparing a distance between the current vehicle position and the nearest intersection with a predetermined value; and an birds-eye view road map forming means 4E. Further, the birds-eye view road map forming means 4E is further provided with visual point E(x, y, z) setting means 4E-1; vertical overlook angle (.theta.) setting means 4E-2; horizontal visual line direction (.phi.) setting means 4E-3; visual line end position (F) setting means 4E-4; visual line length (.vertline.EF.vertline.) calculating means 4E-5; etc.

Detailed Description Paragraph Right (4):
Here, with reference to FIG. 9, when an birds-eye view road map is required to be formed, it is necessary to decide the visual point E (x, y, z) and the visual line end position F (x, y, 0). Here, the visual line end position F is set near to a specific position on the road map (e.g, a current vehicle position CVP). Upon decision of the visual point E and the visual line end position F, a vertical overlook (visual line) angle .theta. from the x-y plane, a horizontal visual line direction .phi. from the x-axis, and the visual line length .vertline.EF.vertline. (vector) between E and F can be determined.

Detailed Description Paragraph Right (5):
The first aspect of the vehicle navigation system according to the present invention will be described hereinbelow. The feature of the first aspect is to form the birds-eye view road maps of various visual points and various contraction scale ratios according to vehicle travel speed. The basic embodiment of the first aspect of the present invention will be explained hereinbelow.

Detailed Description Paragraph Right (6):
In the vehicle navigation system, when an ignition switch is turned to any position of ACC, IGN and START, the CPU 4 starts to execute the procedure as shown by a flowchart in FIG. 6.

Detailed Description Paragraph Right (7):
That is, in step S1, the CPU 4 (referred to as control, hereinafter) reads a destination inputted through the operation key board 9.

Detailed Description Paragraph Right (8):
In step S2, control calculates a recommendable vehicle travel route from a start point and the destination by searching various routes in accordance with the well-known searching method (See Japanese Published Unexamined Patent Application No. 62-86499). Here, the start point can be inputted through the operation key board 9 or detected on the basis of the GPS signal received by the GPS receiver 10.

Detailed Description Paragraph Right (9):
In step S3, control counts the number of speed pulses (outputted by the vehicle speed sensor 2) per unit time and detects the vehicle travel speed and further calculates the vehicle travel distance. Further, control calculates a vehicle travel locus on the

basis of the calculated vehicle travel distance and the travel azimuth detected by the azimuth sensor 1, and compares with the calculated vehicle travel locus with the road map data stored in the road map memory 3 to specify the current vehicle position CVP. Further, it is also possible to calculate and specify the vehicle travel speed and the current vehicle position CVP on the basis of the GPS signals received by the GPS receiver 10.

Detailed Description Paragraph Right (11):
In step S5, control calculates a road map range to be displayed on the display unit 8. In more detail, control decides the range where the trapezoidal range ABCD shown in FIG. 2 is displayed as the road map on the display unit 8.

Detailed Description Paragraph Right (12):
In step S6, control reads road map data corresponding to the road map range decided in step S5 from the load map memory 3.

Detailed Description Paragraph Right (13):
In step S7, control transforms the road map data read from the road map memory in step S6 into birds-eye view road map data. In other words, control transforms the road map data in the trapezoidal range ABCD shown in FIG. 2 into image data to be displayed as a road map in the range abcd also shown in FIG. 2.

Detailed Description Paragraph Right (14):
The above-mentioned transformation can be executed in accordance with the transformation formula as follows: ##EQU1## where (Vx, Vy, 0) denote the coordinates of the visual point E; (Mx, My, 0) denote the coordinates on the usual road map; (Sx, Sy) denote the coordinates on the birds-eye view road map; and (Ex, Ey, Ez) denote intermediate values for obtaining the coordinates (Sx, Sy).

Detailed Description Paragraph Right (15):
Further, in step S7, after the image data have been formed, the color of the recommendable route obtained in step S2 is determined so as to be distinguishable from that of the birds-eye view road map data. Further, a vehicle mark indicative of the current vehicle position CVP (obtained in step S3) is also synthesized with the image data (e.g., in the form of an arrow as shown in FIGS. 16A and 16B).

Detailed Description Paragraph Right (16):
In step S8, the image data formed in step S8 are transferred to the V-RAM 7 to display the transformed road map data of the birds-eye view on the display unit 8.

Detailed Description Paragraph Right (17):
In step S9, control discriminates whether the vehicle travels by a travel distance longer than a predetermined value on the basis of the output signal of the vehicle speed sensor 2 or the GPS signal. If YES, control returns to the step S3 to calculates the visual point E and the visual line direction EF again, and displays again the birds-eye view road map data on the basis of the recalculated results. On the other hand, if NO in step S9, control remains at the same step S9.

Detailed Description Paragraph Right (19):
In step S21, control first reads a start point and a destination point both inputted from the operation key board 9, for instance.

Detailed Description Paragraph Right (20):
Further, in step S22, control detects the current vehicle speed by counting the number of pulses per unit time or measuring the pulse period both outputted by the vehicle speed sensor 2 and further calculates the travel distance by multiplying the detected current speed by the unit time. In addition, control calculates the vehicle travel locus on the basis of the calculated vehicle travel distance and a vehicle travel azimuth detected by the azimuth sensor 1, and detects the current vehicle position CVP by comparing the obtained distance and the azimuth with the road map data stored in the road map memory 3 (map matching). The method of detecting the current position as described above is referred to as an autonomous navigation. However, it is also possible to detect the current vehicle position CVP on the basis of the GPS signal received by the GPS signal receiver 10, as already explained.

Detailed Description Paragraph Right (21):
In step S23, control calculates a recommendable vehicle travel route from the start point to the destination on the road map.

Detailed Description Paragraph Right (22):
In step S24, control extracts specific traffic points (e.g., specific intersections (referred to as guide intersections, hereinafter)) necessary to guide the vehicle along the recommendable route from the road map memory 3, and further stores various information related to the extracted guide intersections in the RAM 6. The reason why the guide intersections are extracted in this step is as follows: since there are many intersections (e.g., intersections with small roads) unnecessary to guide the vehicle along the recommendable route, when the road map is replaced or redisplayed with another road map so often at all the unnecessary intersections, the load of the CPU 4 increases without having no special significance. Further, the guide intersections are extracted on the basis of the classification of roads (express highways, national roads, prefecture roads, etc.) crossing the recommendable route, the angles of intersections with other roads, the number of crossing roads at the intersection, etc.

Detailed Description Paragraph Right (25):
FIG. 9 shows an example of the visual points E1 and E2 and the visual line length .vertline.EF.vertline. both set in accordance with the flowchart shown in FIG. 8. in which the end position F of the visual line length .vertline.EF.vertline. is set to a position near the current vehicle position CVP on the road map.

Detailed Description Paragraph Right (27):
Further, as shown in FIGS. 10A and 10B and 11, the vertical and horizontal visual field angles 2.gamma. and 2.beta. (within which the road map can be seen from the visual point E) are determined always constant. In other words, as shown in FIGS. 10A and 10B, since the distance Lf between the visual point E and the apparent displayed image range abcd is kept always constant and further the area of the displayed range is also constant, the vertical visual field angles 2.gamma. and the horizontal visual field angle 2.beta. are both kept always constant, irrespective of the visual point E as shown.

Detailed Description Paragraph Right (29):
Further, in step S102, control determines the horizontal visual line direction .phi.. Here, the horizontal visual line direction .phi. can be set to any of various directions (e.g., the vehicle travel direction detected by the azimuth sensor 1, a direction along which the recommendable route can be displayed over the longest distance, a direction from the current vehicle position to the destination, etc.).

Detailed Description Paragraph Right (32):
In step S104, control determines the visual point E on the basis of the visual line end position (current vehicle position) F, the visual line length .vertline.EF.vertline. dependent upon the vehicle speed, the vertical overlook angle .theta. between the axis AA' and the visual point E, and the horizontal visual line direction angle .phi. between the x axis and the axis AA'.

Detailed Description Paragraph Right (33):
In the example shown in FIG. 9, the visual point E is set to E1 when the vehicle speed is low, but to E2 when high. Further, when the visual point is E1, the displayed map range is a trapezoidal range A1-B1-C1-D1; and when the visual point is E2, the displayed map range is a trapezoidal range A2-B2-C2-D2, respectively.

Detailed Description Paragraph Right (34):
FIG. 11 shows a view in which the direction AA' shown in FIG. 9 is taken along the abscissa, and the z-axis shown in FIG. 9 is taken along the ordinate. As shown, when the visual point is E1, the displayed map range is a small range G1-H1; and when the visual point is E2, the displayed map range is a large range G2-H2, respectively. Therefore, when the visual point is E2, a broader road map can be displayed.

Detailed Description Paragraph Right (35):
As described above, in the first embodiment, the overlook angle .theta. from the visual point E is kept constant, and the visual line length .vertline.EF.vertline. is

changed according to the vehicle speed. That is, the higher the vehicle speed is, the longer will be the visual line length. Therefore, the higher the vehicle speed is, the broader will be the road map range; or the lower the vehicle speed is, the narrower will be the road map range, so that the more detail road map near the current vehicle position can be displayed at low vehicle speed. Accordingly, the displayed road map can satisfy the driver's request.

Detailed Description Paragraph Right (39):
Further, in the first embodiment, when the vehicle speed is very high, since the road network information to be displayed on the display unit 8 increases excessively, the road map is not easy to see. In this case, it is preferable to display only the important information related to an express highway or a major road, for instance.

Detailed Description Paragraph Right (41):
In this second embodiment, as shown in FIG. 13, the visual line length .vertline.EF.vertline. between the visual point E and the visual line end position F is kept always constant, and only the vertical overlook angle .theta. is changed according to the vehicle speed. Further, in this embodiment, the visual line end position F is decided near the current vehicle position CVP on the road map in the same way as with the case of the first embodiment.

Detailed Description Paragraph Right (46):
In step S204, control determines the visual point E on the basis of the visual line end position (current vehicle position) F, the constant visual line length .vertline.EF.vertline., the vertical overlook angle .theta. between the axis AA' and the visual point E dependent upon the vehicle speed, and the horizontal visual line direction angle .phi. between the x axis and the axis AA'.

Detailed Description Paragraph Right (47):
In the example shown in FIG. 13, when the vehicle speed is high, the vertical overlook angle .theta. is set to .theta.3 and therefore the visual point is set to E3, so that the road map range to be displayed is A3-B3-C3-D3. On the other hand, when the vehicle speed is slow, the vertical overlook angle .theta. is set to .theta.4 and therefore the visual point is set to E4, so that the road map range to be displayed is A4-B4-C4-D4.

Detailed Description Paragraph Right (48):
FIG. 14 shows a view in which the direction AA' shown in FIG. 13 is taken along the abscissa, and the z-axis shown in FIG. 13 is taken along the ordinate. As shown, when the visual point is E3, the displayed map range is G3-H3; and when the visual point is E4, the displayed map range is G4-H4, respectively. Therefore, as shown in FIGS. 13 and 14, the higher the vehicle speed is, the smaller will be the vertical overlook angle .theta. so that a broader road map can be displayed.

Detailed Description Paragraph Right (49):
As described above, in the second embodiment, the distance between the visual point E and the end F of the visual line length EF is always kept constant, and only the vertical overlook angle .theta. between the axis AA' and the visual line direction EF is changed according to the vehicle speed. Therefore, in practice, the higher the vehicle speed is, the smaller will be the vertical overlook angle .theta. or the lower the vehicle speed is, the larger will be the vertical overlook angle .theta.. Accordingly, when the vehicle speed is high, the broader road map can be displayed; and when the vehicle speed is low, the narrower road map near the current vehicle position can be displayed in detail. Further, in this second embodiment, since the distance between the visual point E and the visual lie end position F (the current vehicle position CVP) is kept always constant, even if the displayed road map is switched according to the vehicle speed, it is possible to obtain the road maps in roughly the same contraction scale ratio at the current vehicle position, so that the displayed road map is easy to see.

Detailed Description Paragraph Right (50):
In the above-mentioned embodiments, although the navigation system provided with the function for calculating a recommendable route from a start point to a destination has been explained, the present invention can be applied to the navigation system having no such calculating function as described above.

Detailed Description Paragraph Right (51):
Further, it is also preferable to display the determined visual point E and visual line direction EF on the display unit whenever the road maps are switched according to the vehicle speed.

Detailed Description Paragraph Right (52):
The second aspect of the vehicle navigation system according to the present invention will be described hereinbelow. The feature of the second aspect is to change the horizontal visual line direction .phi. according to the distance d between the current vehicle position CVP and a specific traffic point (e.g., the nearest intersection along the recommendable travel route).

Detailed Description Paragraph Right (55):
In step S12, control discriminates whether the vehicle travels by a predetermined distance or not on the basis of the sensor pulse outputted by the vehicle speed sensor 2 or the GPS signal. If NO in step S12, control returns to the step S11. If YES, controls proceeds to step S13.

Detailed Description Paragraph Right (57):
In step S14, control reads road map data to the nearest guide intersection in the travel direction from the RAM 6. If NO, control proceeds to the step S15.

Detailed Description Paragraph Right (60):
In step S17, the horizontal visual line direction .phi. is decided. That is, control decides the visual point E in the sky opposite to the current vehicle position along the vehicle travel direction (behind the vehicle current position), and further decides the visual line end position F to the nearest guide intersection in such a way that the nearest guide intersection can be seen downward from the decided visual point E in the visual line direction EF. In other words, the visual line direction angle .phi. or axis AA' from the x axis (See FIG. 9) is also set to the nearest intersection (not the current vehicle position CVP).

Detailed Description Paragraph Right (62):
Upon completion of the step S17 or S18, control proceeds to step S19, and reads the road map data within a predetermined road map range from the road map memory 3. That is, the road map data necessary within the range (ABCD in FIG. 2) corresponding to the decided visual point E and the decided visual line direction EF both decided in step 17 or 18 from the road map memory 3.

Detailed Description Paragraph Right (63):
In step S20, control converts the road map data read in step S19 into data necessary for an birds-eye view road map and displays the converted road map data on the display unit 8. An example of the birds-eye view obtained by the processing in step S17 is shown in FIG. 16A, and an example of the birds-eye view obtained by the processing in step S18 is shown in FIG. 16B, respectively. In more detail, when the vehicle (an arrow) approaches the nearest guide intersection, the guide intersection is displayed substantially vertically at roughly the center of the display as shown in FIG. 16A. On the other hand, when the vehicle travels a long distance ahead from the nearest guide intersection, a point P a predetermined distance ahead from the current vehicle position (an arrow) along the recommendable route is displayed at roughly the central portion of the display as shown in FIG. 16B. Here, the point P is not actually shown on the display unit 8. Further, the vehicle current position is shown at roughly the same middle lower side portion of the display, irrespective of the distance d to the guide intersection. Further, the displayed map range shown in the display unit 8 is roughly the same, irrespective of the distance to the guide intersection.

Detailed Description Paragraph Right (64):
As described above, in the first embodiment of the second aspect, when the distance d from the current vehicle position to the next guide intersection in the vehicle travel direction is short, since the forward direction (in which the current position and the next guide intersection are connected to each other) is displayed substantially vertically at roughly the central portion on the display unit 8, the driver can well see and know the next guide intersection more securely. On the other hand, when the distance from the current vehicle position to the next guide intersection is long,

since the forward direction (in which the current position and a frontward position a predetermined distance ahead from the current position along the recommendable route) is displayed substantially vertically at roughly the central portion on the display unit 8, the driver can well see and know the mutual positional relationship between the current position and the frontward position along the recommendable route. Further, when the above-mentioned predetermined distance ahead from the current vehicle position is decided relatively long, it is possible to display the recommendable route over a long distance on the display unit 8.

Detailed Description Paragraph Right (65):
Further, since the current vehicle position and the road map range are both always displayed in the same way, irrespective of the distance to the next guide intersection, whenever the birds-eye view road map is replaced with a new one, the driver can securely see the current vehicle position without losing the sight of the current vehicle position on the display unit 8.

Detailed Description Paragraph Right (66):
The second embodiment of the second aspect according to the present invention will be described. In the first embodiment, when the distance d between the current vehicle position and the next guide intersection is less than a predetermined value D, the horizontal visual line direction .phi. is set to the next guide intersection to display the next guide intersection vertically on the road map. In this second embodiment, when the distance d between is less than a predetermined value D, the horizontal visual line direction .phi. is set to the vehicle travel direction to display the vehicle travel direction vertically on the road map.

Detailed Description Paragraph Right (68):
In step S57, the vertical visual line angle .phi. is decided. That is, control decides the visual point E in the sky opposite to the current vehicle position along the vehicle travel direction (behind the vehicle current position), and further decides the visual line end position F to a point a predetermined distance ahead in the travel direction in such a way that the current vehicle travel direction can be seen downward from the decided visual point E in the visual line direction EF. In other words, the visual line direction angle .phi. or axis AA' from the x axis (See FIG. 9) is set to the vehicle travel direction (not the nearest intersection). Accordingly, the road map ahead of the current vehicle position along the vehicle travel direction can be displayed vertically on the display unit 8.

Detailed Description Paragraph Right (69):
As described above, in the second embodiment, when the distance from the current vehicle position to the nearest guide intersection along the vehicle travel direction is short, since the vehicle travel direction can be displayed vertically on the display unit 8, the driver can well see and know the next guide intersection more securely, thus preventing the vehicle from being deviated from the recommendable route.

Detailed Description Paragraph Right (76):
In step S108, control forms birds-eye view road maps at the selected vertical overlook angles .theta.1 to .theta.m, and calculates the recommendable route distances in the respective calculated birds-eye view road maps.

Detailed Description Paragraph Right (77):
In step S109, control selects a vertical overlook angle .theta. at which the longest recommendable route distance can be displayed, and decides this vertical overlook angle .theta. as the visual line direction EF, to display the recommendable route over the longest distance.

Detailed Description Paragraph Right (78):
In steps S19 and 20, control executes the same processing as shown in FIG. 15 to display the formed birds-eye view on the display unit 8.

Detailed Description Paragraph Right (79):
As described above, in the third embodiment, the selection limit range .alpha. of the vertical overlook angle .theta. is changed according to the distance d between the current vehicle position and the nest guide intersection. When the distance to next

guide intersection is short, since the selection range .alpha. of the visual direction can be narrowed, it is possible to display the guide intersection more securely on the display unit 8. On the other hand, when the distance to next guide intersection is long, since the selection range .alpha. of the visual direction can be widened, it is possible to select the visual direction in such a way that the recommendable route can be display over the long distance on the display unit 8.

Detailed Description Paragraph Right (80):
The fourth embodiment of the second aspect according to the present invention will be described. In this fourth embodiment, the visual point E (the horizontal distance between the visual point (x) and the current vehicle position is changed according to the distance d between the current vehicle position and the next intersection. Therefore, the map range or the map contraction scale ratio in the vicinity of the current vehicle position can be changed freely according to the distance to the next guide intersection.

Detailed Description Paragraph Right (85):
Upon the end of step S207 or S208, control proceeds to step S209, and sets the visual line end position F on a line obtained when the current vehicle position is connected to the next guide intersection. Owing to the step S209, when the distance L between the two is short, since the visual point E is decided as shown by E1 in FIG. 9, the displayed load map range A1-B1-C1-D1 is small as shown. On the other hand, when the distance L between the two is long, since the visual point E is decided as shown by E2 in FIG. 9, the displayed load map range A2-B2-C2-D2 is larger than that obtained from the visual point E1.

Detailed Description Paragraph Right (86):
In steps S19 and S20, the road map of birds-eye view is formed in the same way as with the case of the other embodiments.

Detailed Description Paragraph Right (87):
As described above, in this fourth embodiment, since the visual point E is changed according to the distance to the next guide intersection without changing the vertical overlook angle (.theta.), it is possible to freely change the road map range displayed on the display unit 8 or the contraction scale ratio of the birds-eye view road map.

Detailed Description Paragraph Right (88):
The fifth embodiment of the second aspect according to the present invention will be described. In this fifth embodiment, the visual point height is changed according to the distance d between the current vehicle position and the next intersection, without changing the visual line length EF. Therefore, the map range or the map contraction scale ratio in the vicinity of the current vehicle position can be changed freely according to the distance to the next guide intersection.

Detailed Description Paragraph Right (93):
Upon the end of step S157 or S158, control proceeds to step S159, and sets the vertical overlook angle .alpha. according to the distance to the next intersection. In other words, the height of the visual point E can be changed according to the distance d to the next intersection. After that, control proceeds to step S160, and sets the visual line end position F on a line obtained when the current vehicle position is connected to the next guide intersection or an extension thereof. Owing to the step S159, when the distance d to the next intersection is small, since the vertical overlook angle .theta.4 is large, the visual point E4 is high as shown in FIG. 13, so that the displayed load map range A4-B4-C4-D4 is small as shown. On the other hand, when the distance d to the next intersection is large, since the vertical overlook angle .theta.4 is small, the visual point E3 is low as shown in FIG. 13, so that the displayed load map range A3-B3-C3-D3 is large as shown.

Detailed Description Paragraph Right (94):
In steps S19 and S20, the road map of birds-eye view is formed in the same way as with the case of the other embodiments.

Detailed Description Paragraph Right (95):
As described above, in this fifth embodiment, since the visual point height or the vertical overlook angle .theta. is changed according to the distance to the next guide

intersection, it is possible to freely change the road map range displayed on the display unit 8 or the contraction scale ratio of the birds-eye view road map.

Detailed Description Paragraph Right (96):
In this fifth embodiment, the height of the visual point is changed according to the distance between the current vehicle position and the next guide intersection, so that the road map in the vicinity of the current vehicle position can be displayed at almost the same contraction scale ratio, irrespective of the distance to the next guide intersection.

Detailed Description Paragraph Right (97):
As described above, in the fifth embodiment, when the vehicle approaches the guide intersection, the guide intersection and the vicinity thereof can be displayed in an enlarge scale. On the other hand, when the distance to the next guide intersection is long, the road map can be displayed at a relatively wide range toward the destination.

Detailed Description Paragraph Right (101):
As described above, in the vehicle navigation system according to the present invention, since the birds-eye view road maps of various visual points and various contraction scale ratios can be displayed appropriately according to the vehicle speed or the distance between the current vehicle position and a specific traffic point (e.g., the nearest intersection), the driver can see the road map under the best conditions at all times.

CLAIMS:

1. A vehicle navigation system, comprising:

vehicle position setting means for setting a start point and a destination of a vehicle;

vehicle speed sensing means for detecting vehicle travel speed;

vehicle travel azimuth detecting means for detecting vehicle travel direction;

road map data storing means for storing road map data related to various roads;

vehicle position detecting means for detecting a current vehicle position on the basis of the detected vehicle speed and travel direction after the start point and in accordance with road map data;

recommendable route calculating means for calculating a recommendable route from the start point to the destination on the basis of the road map data;

specific point extracting means for extracting specific traffic points for the vehicle to be guided from the calculated recommendable route;

distance comparing means for comparing a distance between the current vehicle position and one of the extracted specific traffic points with a predetermined value;

birds-eye view forming means for forming an birds-eye view road map taken from a visual point located in the sky behind the current vehicle position; the visual point being determined on the basis of a visual line end position, a visual line length, a vertical overlook angle, and a horizontal visual line direction angle according to a distance between the current vehicle position and one of the extracted specific traffic points; and

display means for displaying the formed birds-eye view road map.

2. The navigation system of claim 1, wherein one of the extracted specific traffic points is a nearest guide intersection crossing the recommendable route.

3. The navigation system of claim 2, wherein said birds-eye view forming means sets the visual line end position to the nearest guide intersection, to display the nearest

guide intersection substantially vertically on the display means, when the compared distance to the nearest guide intersection is shorter than the predetermined value; but to a point a predetermined distance ahead from the current vehicle position along the recommendable route, to display the recommendable route substantially vertically on the display means, when the compared distance to the nearest guide intersection is longer than the predetermined value.

4. The navigation system of claim 2, wherein said birds-eye view forming means sets the visual line end position to a point in the vehicle travel direction, to display the vehicle travel direction substantially vertically on the display means, when the compared distance to the nearest guide intersection is shorter than the predetermined value; but to a point a predetermined distance ahead from the current vehicle position along the recommendable route, to display the recommendable route substantially vertically on the display means, when the compared distance to the nearest guide intersection is longer than the predetermined value.

5. The navigation system of claim 2, wherein said birds-eye view forming means sets the vertical overlook angle at which the recommendable route can be displayed over the longest distance, by calculating several displayed recommendable routes within the vertical overlook limit angle determined according to the detected distance between the current vehicle position to the nearest guide intersection.

6. The vehicle navigation system of claim 2, wherein said birds-eye view forming means sets the visual point to a lower point near behind away from the current vehicle position when the compared distance to the nearest guide intersection is shorter than the predetermined value, but to a higher point far behind away from the current vehicle position when the compared distance to the nearest guide intersection is longer than the predetermined value, while keeping the vertical overlook angle at a constant value irrespective of the distance between the two; said birds-eye view forming means further setting the visual line end position to a line between the current vehicle position and the nearest guide intersection to display the nearest guide intersection substantially vertically on the display means, irrespective of the distance between the two.

7. The vehicle navigation system of claim 2, wherein said birds-eye view forming means sets the visual point to a higher point near behind away from the current vehicle position when the compared distance to the nearest guide intersection is shorter than the predetermined value, but to a lower point far behind away from the current vehicle position when the compared distance to the nearest guide intersection is longer than the predetermined value, while keeping a distance between the visual point and the current vehicle position at a constant value irrespective of the distance between the two; said birds-eye view forming means further setting the visual line end position to a line between the current vehicle position and the nearest guide intersection or an extension thereof to display the nearest guide intersection substantially vertically on the display means, irrespective of the distance between the two.

8. A method of guiding an automotive vehicle, comprising the steps of:

setting a start point and a destination of a vehicle;

detecting vehicle travel speed;

detecting vehicle travel direction;

storing road map data related to various roads;

detecting a current vehicle position on the basis of the detected vehicle speed and travel direction after the start point in accordance with road map data;

calculating a recommendable route from the start point to the destination on the basis of the road map data;

detecting whether the vehicle has passed through an intersection;

if has passed the intersection, reading a nearest intersection from the stored road

map data;

if not passed through the intersection, calculating a distance d from the current vehicle position to the nearest intersection;

forming a birds-eye view road map taken from a visual point located in the sky behind the current vehicle position, by changing the visual point determined on the basis of a visual line end position, a visual line length, a vertical overlook angle, and a horizontal visual line direction angle, according to the calculated distance d to the nearest intersection;

calculating a road range to be displayed;

reading road map data from the stored road map data;

transforming the road map data into birds-eye view road map data;

storing the transformed birds-eye view road map data;

displaying the formed and stored birds-eye view road map; and

updating the birds-eye view road map for each predetermined vehicle travel distance.

9. The method of guiding an automotive vehicle of claim 8, wherein the step of forming the birds-eye view road map comprises the steps of:

if the calculated distance d is shorter than the predetermined distance D, setting the visual point behind the current vehicle position and further setting the visual line end position to the nearest intersection; and

if the calculated distance d is longer than the predetermined distance D, setting a visual point behind the current vehicle position and further setting the visual line end position to a point predetermined distance ahead from the current vehicle position along the recommendable route.

10. The method of guiding an automotive vehicle of claim 8, wherein the step of forming the birds-eye view road map comprises the steps of:

if the calculated distance d is shorter than the predetermined distance D, setting the visual point behind the current vehicle position and further setting the visual line end position to a point along a vehicle travel direction; and

if the calculated distance d is longer than the predetermined distance D, setting the visual point behind the current vehicle position and further setting the visual line end position to a point a predetermined distance ahead from the current vehicle position along the recommendable route.

11. The method of guiding an automotive vehicle of claim 8, wherein the step of forming the birds-eye view road map comprises the steps of:

calculating a vertical overlook limit angle .alpha. in accordance with a formula as

.alpha.=k.times.d/d+c

where k and D denote a constant, respectively;

selecting vertical overlook angles within the calculated vertical overlook limit angle;

forming birds-eye view road maps at the selected vertical overlook angles;

selecting one of the vertical overlook angles at which the recommendable route can be displayed over the longest distance;

forming an birds-eye view road map by changing the visual point on the basis of the

selected vertical overlook angle.

12. The method of guiding an automotive vehicle of claim 8, wherein the step of forming the birds-eye view road map comprises the steps of:

if the calculated distance d is shorter than the predetermined distance D, calculating a distance L between the visual point and the current vehicle position in accordance with a formula as

L=j1.times.d+j2

where j1 and j2 denote a constant, respectively;

if the calculated distance d is longer than the predetermined distance D, setting the distance L to a fixed value L0;

setting the visual line end position to a line between the current vehicle position and the nearest intersection; and

forming an birds-eye view road map taken from a visual point, by changing the visual point on the basis of the calculated distance L between the visual point and the current vehicle position, and the set visual line end position, while keeping the vertical overlook angle at a constant value.

13. The method of guiding an automotive vehicle of claim 8, wherein the step of forming the birds-eye view road map comprises the steps of:

if the calculated distance d is shorter than the predetermined distance D, calculating the vertical overlook angle .theta. in accordance with a formula as

.theta.=k5-k6.times.d

where k5 and k6 denote a constant, respectively;

if the calculated distance d is longer than the predetermined distance D, setting the vertical overlook angle .theta. to a fixed value .theta.0;

setting the visual line end position to a line between the current vehicle position and the nearest intersection or an extension line thereof; and

forming an birds-eye view road map taken from a visual point, by changing the visual point on the basis of the calculated vertical overlook angle and the set visual line end position, while keeping the visual line length at a constant value.

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DOCUMENT-IDENTIFIER: US 5774824 A
TITLE: Map-matching navigation system

Abstract Paragraph Left (1):
A map matching navigation system for monitoring vehicle state characteristics including the location of a vehicle on a map route. The map matching navigation system may operate in a fixed mode wherein the map route is inputted by a user or a flexible mode wherein the map matching navigation system determines the map route from a plurality of measured points which correspond to the location of the vehicle. The map matching navigation system additionally updates the location of the vehicle at a plurality of positions on the map route wherein the vehicle location is known with an increased level of confidence.

Brief Summary Paragraph Right (1):
This invention relates to navigation systems and more particularly to navigation systems which utilize map matching for determining a route of travel and the location of a vehicle on the route of travel.

Brief Summary Paragraph Right (2):
Map matching systems were introduced to imitate and automate the working procedures of traditional navigational systems. In particular, map matching systems generally input position and heading data from other locating sub-systems which include dead reckoning (DR) systems, global positioning systems (GPS) and inertial navigation systems (INS). The map matching systems compare the time history of the input data (i.e. vehicle path) with the map route data in the map database. The map matching systems then determine which map route the vehicle is traveling on and subsequently match the measured position and heading onto the appropriate map route.

Brief Summary Paragraph Right (3):
The map route data contained within the map database is vital for a successful map matching system. Therefore, one data source alone is usually not sufficient to achieve the required level of accuracy. Several sources should be utilized to compile a database and thereby eliminate insufficient, inaccurate, or obsolete data.

Brief Summary Paragraph Right (4):
Map matching systems may be used in many navigation applications. First, it may be used to provide vehicle position on a display within a car thereby enabling the driver to determine the current position of the vehicle and plot a route to reach the destination. The map matching system may provide minimal information such as direction and air-line distance to a destination or detailed step-by-step route guidance instructions for reaching a destination.

Brief Summary Paragraph Right (5):
In addition, the individual vehicles may transmit navigation information to a dispatch center for monitoring. Therefore, dispatchers may benefit from map matching systems inasmuch as they may simultaneously know the location of numerous vehicles at any time. The map matching system may also be used in public transportation systems to inform passengers of arrival times and location of the vehicle on the vehicle route.

Brief Summary Paragraph Right (6):
Map matching systems must be able to search and manipulate large amounts of map data to provide real time location information. However, the systems are much more

efficient if the vehicle is traveling along a predetermined route inasmuch as only map data along the route is relevant to the navigation determinations and the size of the "active" map is greatly reduced. The predetermined route technique is applicable to systems wherein the vehicles move along a fixed route. However, this technique may also be extended to more advanced applications such as route planning and route guidance systems.

Brief Summary Paragraph Right (7):
Traditional map matching systems have been found to include numerous sources of error including approximation error, navigation error, and positioning error. Therefore, the error in such a map matching navigation system would grow unboundedly unless it is periodically reduced throughout the monitoring of a vehicle along a map route.

Brief Summary Paragraph Right (8):
There is a need for a map matching navigation system which utilizes map matching for automatically determining vehicle state characteristics in real time. Therefore, the map matching navigation system must be able to efficiently search and manipulate large amounts of data to provide realistic and useful assistance in a flexible navigation mode. In addition, the map matching navigation system must also be able to navigate predetermined route applications wherein the vehicles travels along a fixed route. Furthermore, the map matching navigation system must reduce error which accumulates in the navigator sub-system to provide accurate navigation information.

Brief Summary Paragraph Right (9):
The invention provides a map matching navigation system which may operate in a fixed mode or a flexible mode and continuously reduces accumulated error in the system to provide accurate vehicle state information.

Brief Summary Paragraph Right (10):
The map matching navigation system in accordance with the present invention includes a map database including a plurality of links and a plurality of nodes for defining a map route within a geographical area. The map matching navigation system may additionally include a sensor and a navigator for determining a measured point of the vehicle.

Brief Summary Paragraph Right (11):
The map matching navigation system further includes a correlator coupled with the navigator for determining a matched point on the map route which corresponds to the measured point. In addition, the map matching navigation system may include an analyzer coupled with the correlator for updating the measured point and the matched point to the end of a curve after the vehicle has reached the end of the curve.

Brief Summary Paragraph Right (12):
The map matching navigation system may further include a map route processor for determining the route being travelled upon by the vehicle. The map route processor may utilize one or more statistical parameters based upon the measured points and matched points for determining the appropriate route.

Brief Summary Paragraph Right (13):
The system preferably includes a user interface coupled with the map route processor for conveying the map route and the matched point thereon to a user. In addition, the user interface may be utilized for inputting the initial vehicle location and a predetermined map route, if the map matching navigation system is operating as a fixed navigator, into the system.

Drawing Description Paragraph Right (1):
FIG. 1 is a schematic of a curved portion of the map route;

Drawing Description Paragraph Right (2):
FIG. 2 is a functional block diagram of the map matching navigation system according to the invention;

Drawing Description Paragraph Right (3):
FIG. 3 is a functional block diagram of the map matching navigation system and a central control facility;

Drawing Description Paragraph Right (5):
FIG. 5 is a schematic of a measured point adjacent to a portion of the map route and a corresponding matched point on the map route;

Drawing Description Paragraph Right (7):
FIG. 7 is a flowchart of the process performed by the map matching navigation system for identifying the map route from a plurality of candidate routes;

Drawing Description Paragraph Right (8):
FIG. 8 is a schematic diagram of a portion of a predetermined map route;

Detailed Description Paragraph Right (1):
The accurate operation of the map matching navigation system depends in large part upon the accuracy of the map database 14. Therefore, the map database 14 utilized by the system should be the product of numerous data sources to provide an accurate, current and complete map database 14.

Detailed Description Paragraph Right (2):
The map database 14 utilized by the map matching navigation system according to the invention may be a two dimensional model. All map routes in such a map database 14 are one-way roads. Therefore, all two-way roads are modeled as two one-way roads. The map database 14 may be stored in a CD ROM, cassette or other computer readable memory 16. Accordingly, the map database 14 may be easily updated and the map databases 14 may be changed depending upon the geographical location of the vehicle 4.

Detailed Description Paragraph Right (3):
The map routes modeled within the map database 14 include basic map elements such as a plurality of key nodes 30, shaping nodes 32 and links 34 as shown in FIG. 1. Road intersections and bus stops can be modelled as key nodes 30 while shaping nodes 32 define curves in the road and model long straight road segments which are devoid of intersections and bus stops. The straight lines which connect the nodes represent road segments and are defined as links 34.

Detailed Description Paragraph Right (4):
The approximation accuracy of curves in the map database increases with the number of shaping nodes 32. The basic attributes of the nodes can include x, y and z coordinates and yaw angles which may be measured counterclockwise with respect to the east. The basic attributes of the links 34 are distance and direction.

Detailed Description Paragraph Right (5):
The map matching navigation system according to the invention may operate in two modes. In a first mode, the map matching navigation system operates as a flexible navigator. The map matching navigation system in this mode calculates the map route 8 of the vehicle 4 based upon a plurality of measured points 26.

Detailed Description Paragraph Right (6):
The map matching navigation system may operate as a fixed navigator in a second mode wherein the system calculates the position of the vehicle 4 on the predetermined map route 8. The predetermined map route 8 may be inputted by a user into the map matching navigation system via a user interface 18 such as a keyboard, graphical screen or personal computer MIA slot.

Detailed Description Paragraph Right (7):
The map matching navigation system may utilize a variety of methods for measuring the location of the vehicle 4 on the map route 8. The system preferably includes a sensor 10 for determining the distance travelled and azimuthal direction if a dead reckoning (DR) navigation system is utilized.

Detailed Description Paragraph Right (8):
Additionally, the sensor 10 may include at least one accelerometer and at least one gyroscope if an inertial navigation system (INS) is used. The sensor 10 may further include a global positioning system receiver if a global positioning system (GPS) is utilized. In addition, the sensor 10 may include a tag receiver, such as a transponder read device, for receiving vehicle state information from a plurality of tags, such as

transponders, adjacent the actual route 6.

Detailed Description Paragraph Right (9):
An initialization function must be performed if a relative navigation system is used. The operator of the vehicle 4 may input the initialization information (e.g. initial position and heading) via a user interface 18. Alternatively, the intialization information may be automatically inputted into the map matching navigation system via an automatic tag system or a global positioning system.

Detailed Description Paragraph Right (10):
A functional block diagram of the entire map matching navigation system is shown in FIG. 2. The individual functions are described in detail following the overall description of the system in relation to FIG. 2.

Detailed Description Paragraph Right (11):
The sensor 10 provides vehicle state information which is forwarded to a navigator 12. The navigator 12 calculates a measured point 26 of the vehicle 4 based upon the vehicle state information. A map route processor 65 determines the appropriate portion of the map route 8 which corresponds to the measured point 26. A correlator 63 receives the measured point 26 and map route 8 information from the map route processor 65 and the correlator 63 subsequently determines a matched point 28 on the map route 8 which corresponds to the measured point 26.

Detailed Description Paragraph Right (12):
An analyzer 64 simultaneously detects curves in the map route 8 which exceed a threshold value. The map matching navigation system updates the measured point 26 and the matched point 28 with the last key node 30 of the curve as the vehicle 4 exits the curve. Updating the measured point 26 and the matched point 28 with the end of the curve reduces accumulated error within the map matching navigation system because the position of the vehicle 4 is known with a high degree of certainty as it exits the curve. The map route 8 and matched point 28 may be conveyed to an operator of the vehicle 4 via the user interface 18.

Detailed Description Paragraph Right (13):
In addition, the user may input a predetermined map route 8 via the user interface 18 if the map matching navigation system is operating as a fixed navigator. The predetermined route may be stored in a computer readable memory 16 as shown in FIG. 3.

Detailed Description Paragraph Right (14):
The map route processor 65 determines the current link 35 on which the vehicle 4 is travelling from the plurality of measured points 26. In addition, the map route processor 65 may also determine the appropriate map route 8 through an analysis of the measured points 26 and the map database 14.

Detailed Description Paragraph Right (15):
The navigator 12, correlator 63, analyzer 64 and the map route processor 65 may be implemented in a central processor 37 on board the vehicle 4. In addition, the central processor 37 utilize a working RAM 21 to perform map matching functions.

Detailed Description Paragraph Right (16):
As depicted in FIG. 3, the map matching navigation system may further include a first transceiver 22 for transmitting vehicle position information to a central control facility 24 or a similar vehicle monitoring facility, and receiving route information or other communications from the central control facility 24 or other remote positions. The central control facility 24 may be present for monitoring a plurality of vehicles 4 equipped with the map matching navigation system according to the invention.

Detailed Description Paragraph Right (17):
As shown in FIG. 4, the locus of measured points 26 from the navigator 12 will deviate from a map route 8 due to numerous sources of error including approximation error, digitization error, database error and sensor error.

Detailed Description Paragraph Right (18):

For map matching, each measured point 26 should have a corresponding matched point 28 along the map route 8. The matched point 28 preferably represents the vehicle's real position with the highest probability. As shown in FIG. 5, a point along the link 34 with the smallest distance to the measured point 26 is the point having the smallest contour of equal probability and most probable position of the matched point 28.

Detailed Description Paragraph Right (20):
Thus, the map matching navigation system may estimate the location of a vehicle 4 on a map route 8 despite deviations between the map route 8 and the set of measured points 26.

Detailed Description Paragraph Right (21):
As shown in FIG. 5, the deviation of the map route 8 from an actual route 6 at one point may be represented by the deviation distance 36 from the measured point 26 to the matched point 28. The signed deviation distance 36 from each measured point 26 to its corresponding matched point 28 may be calculated from the following equation: ##EQU2##

Detailed Description Paragraph Right (22):
Random variables and statistical parameters may be introduced to represent the degree of deviation of the map route 8 from the actual route 6. The degree of deviation may be estimated by obtaining a plurality of deviation distances 36 for a plurality of measured points 26. The mean distance deviation d and sample variance s may be calculated from the history of individual deviation distances 36: ##EQU3##

Detailed Description Paragraph Right (23):
The mean distance deviation d for a particular map route 8 should be approximately zero if the vehicle 4 is moving along the map route 8. However, the sample variance s should be quite large even if the mean distance deviation d is around zero. Therefore, the mean distance deviation d and the sample variance s statistically indicate the closeness between the plurality of measured points 26 on the actual route 6 and the map route 8.

Detailed Description Paragraph Right (24):
These statistical parameters may be utilized to identify the specific map route 8 on which the vehicle 4 is travelling from a plurality of candidate routes 9. In addition, the heading of the vehicle 4 provides important information about the current location of the vehicle 4, especially when the vehicle 4 is approaching an intersection having numerous candidate routes 9 as shown in FIG. 6a.

Detailed Description Paragraph Right (25):
The map route processor 65 of the map matching navigation system will retrieve specific data from the map database 14 regarding candidate routes 9a-9c as the vehicle 4 approaches an intersection as shown in FIG. 6a. The correlator 63 of the system monitors the vehicle position with respect to each candidate route 9a-9c until the appropriate map route 8 is identified and the other candidate routes 9a-9c are discarded.

Detailed Description Paragraph Right (26):
As shown in FIG. 6a, the heading of the vehicle 4 before it makes a turn is very close to that of a current map route 8. The heading of the vehicle 4 after a turn is very close to that of a first candidate route 9c as shown in FIG. 6b.

Detailed Description Paragraph Right (27):
A correlation characteristic may be defined to collectively represent the degree of matching between the plurality of measured points 26 from the actual route 6 and the plurality of matched points 28 on the map route 8. The correlation characteristic is composed of two components including a heading component (C.sub.heading) and a distance component (C.sub.distance) and is defined by the following equation wherein W.sub.1 and W.sub.2 are weighting factors and W.sub.1 +W.sub.2 =1:

Detailed Description Paragraph Right (28):
The components are defined by the following equations wherein .vertline..DELTA..PSI..vertline.=.vertline..PSI..sub.vehicle -.PSI..sub.map .vertline. (the heading deviation from the map route 8), and .PSI.=.pi. (the maximum allowable

heading deviation), and D is the maximum allowable lateral distance deviation and S is the maximum allowable sample variance: ##EQU4##

Detailed Description Paragraph Right (30):
The correlation characteristics may be utilized by the map matching navigation system functioning as a flexible navigator to determine which particular map route 8 the vehicle 4 is travelling upon when there is a plurality of candidate routes connected to a single key node 30 as shown in FIG. 6a.

Detailed Description Paragraph Right (32):
The flowchart shown in FIG. 7 represents a process for determining the appropriate route on which the vehicle 4 is travelling when the map matching navigation system is operating as a flexible navigator. The vehicle state information is determined by the sensor 10 and the navigator 12 in step 70. The vehicle state information is utilized by the map route processor 65 in step 71 to retrieve data regarding candidate routes 9. In step 72, the correlator 63 of the map matching navigation system computes a matched point 28 on each link 34 from the candidate routes 9. Next, the correlator 63 calculates the deviation distance 36 for each matched point 28 in step 73 and the correlation characteristics corresponding to each matched point in step 74.

Detailed Description Paragraph Right (33):
The map route processor 65 in step 75 compares the correlation characteristic of each candidate route 9 to a maximum correlation characteristic. The other candidate routes 9 are discarded in step 76 if the correlation characteristic of one route exceeds the maximum correlation characteristic and the map matching navigation system may update the vehicle location data in step 77.

Detailed Description Paragraph Right (34):
All candidate routes 9 are compared to a minimum correlation characteristic in step 78. All candidate routes 9 having a correlation characteristic below the minimum value are discarded in step 79. The map matching navigation system in step 80 will continue to track candidate routes 9 having a correlation characteristic above the minimum correlation characteristic. In step 81, the map matching navigation system updates the measured point with the matched point through the utilization of map matching techniques in accordance with the present invention to correct error within the system.

Detailed Description Paragraph Right (35):
The map matching navigation system continues to monitor the vehicle state information in order to identify the particular route of travel after the correction error is determined.

Detailed Description Paragraph Right (36):
The map matching navigation system may also operate as a fixed navigator wherein the vehicle 4 travels on a predetermined map route 8 inputted via the user interface 18 by the vehicle operator. When the vehicle 4 makes a turn the map matching navigation system merely searches for a corresponding turn in the predetermined map route 8 and may update the vehicle location.

Detailed Description Paragraph Right (37):
The map matching navigation system operating as a fixed navigator accommodates errors in the map database 14. Referring to FIG. 8, the actual distance between a first road 55 and a third road 57 is 540 meters. However, assume the distance recorded between the first road 55 and third road 57 in the map database 14 is 520 meters and the distance between the third road 57 and a fourth road 58 is 20 meters.

Detailed Description Paragraph Right (38):
As shown in FIG. 8, the map route 8 follows the first road 55 to a left hand turn onto a second road 56 and a left hand turn onto the third road 57. When the vehicle 4 makes a left hand turn from the second road 56 to the third road 57 the correlation characteristic may drop below a threshold value because the vehicle 4 did not turn left after traveling 520 meters.

Detailed Description Paragraph Right (39):
The map matching navigation system operating in the fixed navigator mode may query the

driver via the user interface 18 whether the vehicle 4 has deviated from the predetermined map route 8 after the correlation characteristic drops below a threshold value. The driver may respond via the user interface 18 that they are still on the predetermined map route 8 and the map matching navigation system will correctly resume tracking the vehicle 4 on the third road 57 corresponding to the left hand turn from the second road 56.

Detailed Description Paragraph Right (40):
The map matching navigation system operating in the flexible mode under this scenario would show the vehicle 4 erroneously travelling on the fourth road 58 and the map matching navigation system would have to be reinitialized.

Detailed Description Paragraph Right (41):
Again referring to FIG. 8, assume the proper distance is recorded between the first road 55 and the third road 57 and the map matching navigation system properly tracks the vehicle 4 along the third road 57. However, the third road 57 is unexpectedly closed at a detour point 61 and the driver turns right onto a fifth road 59, left onto the fourth road 58, left onto a sixth road 60 and right onto the third road 57.

Detailed Description Paragraph Right (42):
Operating as a fixed navigator, the map matching navigation system may query the driver via the user interface 18 to indicate whether they deviated from the predetermined map route 8 because the correlation characteristic may drop below the threshold value when the vehicle 4 turned right onto the fifth road 59. The driver would indicate via the user interface 18 that they deviated from the predetermined map route 8. The map matching navigation system would then operate as a flexible navigator to track the vehicle 4 after the vehicle 4 deviated from the predetermined map route 8. The map matching navigation system would automatically return to the fixed mode after the vehicle 4 returns to the predetermined map route 8.

Detailed Description Paragraph Right (43):
The central control facility 24 may continuously track the location of the vehicle 4 as previously described. A dispatcher at the central control facility 24, if aware of the detour point 61, could download an altered predetermined map route 8a around the detour point 61 to the vehicle 4 via the first transceiver 22 and a second transceiver 23. The map matching navigation system would then track the vehicle 4 on the altered predetermined map route 8 without querying the driver.

Detailed Description Paragraph Right (44):
Curves within the map database are approximated by a plurality of shaping nodes 32 and plurality of links 34 within a curve link sequence as shown in FIG. 1. The shaping nodes 32 and links 34 may be tracked in the same manner as nodes and links 34 within the straight portions of the map route 8. However, additional information is processed when the vehicle 4 encounters a turn. In particular, the last key node 30 of a turn provides a position with a high confidence level. The analyzer 64 of the map matching navigation system may utilize the end of the turn as an update point for updating the vehicle position and reducing accumulated error.

Detailed Description Paragraph Right (45):
Therefore, the map matching navigation system may be configured to determine whether the vehicle 4 is located within a turn or a straight portion of the actual route 6. The map matching navigation system may calculate a yaw angle deviation between the most recent measured point 26 and the map route 8 by the following equation to determine whether the vehicle 4 is located within a turn and wherein .PSI. is the yaw angle of the measured location and .PSI..sub.map is the yaw angle of the map link:
##EQU5##

Detailed Description Paragraph Right (47):
The end point of a turn may be used to update the vehicle location on the map route 8 with a high level of confidence. Therefore, the end point of a turn should be calculated if the vehicle 4 is currently travelling in the turn.

Detailed Description Paragraph Right (50):
An update is performed by the analyzer 64 when it is determined that a turn has been completed. Specifically, the next matched point 28 will be located at the last key

node 30 of the curve instead of using a matched point 28. Precisely updating the measured point 26 and matched point 28 on the map route 8 at the end of a curve eliminates accumulated error within the map matching navigation system. The vehicle location is updated at the end of a curve because the position of the vehicle 4 is known with a high degree of certainty.

Detailed Description Paragraph Right (51):
During the working phase of the system, the current link 35 and node information are determined according to vehicle state information and the map database 14 and retrieved from the map database 14. The correlator 63 of the map matching navigation system determines whether a matched point 28 is located on a current link 35 or on a connected link 34 whenever a new group of measurement data is entered from the sensor 10. The matched point 28 may be calculated directly if it is located on the current link 35. Otherwise, the map matching navigation system will search the connected links 34 by the following method to determine the location of the corresponding matched point 28 of a measured point 26.

Detailed Description Paragraph Left (1):
In particular, .PSI..sub.1 is the yaw angle of a measured point 26 at time t1=0 (when a turn is first detected), .PSI..sub.2 is the yaw angle of a measured point 26 at time t2>t1, .PSI..sub.start is the yaw angle for the start node of the turn, and .PSI..sub.end is the yaw angle for the end node of a turn.

Detailed Description Paragraph Left (2):
The map matching navigation system should track the scaler parameters for a previous link (not shown) and the current link 35.

Detailed Description Paragraph Left (3):
The map matching navigation system should track the scaler parameters for the following link 34 and a next link (not shown).

CLAIMS:

1. A map matching navigation system to determine a location of a vehicle on a map route, comprising:

a. a sensor to measure at least one vehicle state characteristic;

b. a navigator coupled with said sensor to determine a measured point of the vehicle based upon the at least one vehicle state characteristic;

c. a map database including a plurality of links and a plurality of nodes to define the map route;

d. a correlator coupled with said navigator and said map database to determine a matched point of the vehicle on the map route which corresponds to the measured point; and

e. an analyzer coupled with said correlator to detect an end of a curve in the map route and updating the measured point and the matched point to the end of the curve.

2. The map matching navigation system of claim 1 further comprising an user interface coupled with said analyzer to convey the map route and the matched point to an user.

3. The map matching navigation system of claim 1 further comprising a computer readable memory to store a predetermined map route.

4. The map matching navigation system of claim 1 wherein said analyzer updates the measured point and the matched point to a node at the end of the curve.

5. The map matching navigation system of claim 4 wherein said navigator, said correlator, and said analyzer are implemented in a central processor.

6. The map matching navigation system of claim 1 further comprising a map route processor coupled with said correlator and said map database and said analyzer, and

said map route processor computes at least one statistical parameter from a deviation distance between the measured point and the matched point to determine the map route from the measured point.

7. The map matching navigation system of claim 6 wherein the analyzer updates the measured point and the matched point to a node at the end of the curve.

8. The map matching navigation system of claim 7 further comprising an user interface coupled with said analyzer to convey the map route and the matched point to an user.

9. The map matching navigation system of claim 8 wherein said map route processor computes at least one statistical parameter from the measured point and the matched point to determine the map route.

10. The map matching navigation system of claim 1 wherein the matched point is the most probable point on the map route which corresponds to the measured point.

11. The map matching navigation system of claim 1 wherein said sensor determines a travelling distance and a travelling direction of the vehicle.

12. The map matching navigation system of claim 1 further comprising at least one of a plurality of tags and a global position system to initialize the location of the vehicle.

13. A method of locating a vehicle on a map route, comprising:

a. measuring at least one vehicle state characteristic;

b. computing a measured point of the vehicle based upon the at least one vehicle state characteristic;

c. correlating the measured point to a matched point on the map route;

d. searching the map route for a curve therein which exceeds a predetermined threshold;

e. updating the measured point and matched point to a point corresponding to the end of the curve; and

f. displaying the map route and the matched point thereon.

14. The method of claim 13 further comprising a step before said step (c) of inputting a predetermined map route.

15. The method of claim 13 further comprising a step after said step (c) of confirming the map route.

18. The method of claim 17 further comprising a step after said step (c) of confirming the map route from the correlation characteristic.

19. The method of claim 13 wherein the at least one vehicle state characteristic is measured by at least one of a dead reckoning system, an inertial navigation system and a global positioning system.

23. A map matching navigation system to determine a location of a vehicle on a map route, comprising:

a. a navigator to determine a measured point of the vehicle;

b. a map database including a plurality of map routes;

c. a correlator coupled with said navigator and said map database to determine at least one matched point of the vehicle on a plurality of candidate routes and each of the at least one matched point corresponds to the measured point;

d. a map route processor coupled with said correlator and said map database, said map route processor calculating at least one statistical parameter from a deviation distance between said at least one measured point and said at least one matched point to determine the map route from a plurality of candidate routes; and

e. an analyzer coupled with said correlator and said map route processor to detect an end of a curve in the map route and update the measured point and the matched point to the end of the curve.

24. The map matching navigation system of claim 23 wherein said map route processor calculates a correlation characteristic for said at least on statistical parameter and confirms a map route from said plurality of candidate routes using said correlation characteristic.

25. The map matching navigation system of claim 24 wherein said map route processor identifies the map route from the candidate routes and the map route has a correlation characteristic within a preselected range.

26. A map matching navigation system to determine a location of a vehicle on a map route, comprising:

a. a navigator to determine a measured point of the vehicle;

b. a map database including a plurality of map routes;

c. a correlator coupled with said navigator and said map database to determine at least one matched point of the vehicle on a plurality of candidate routes and each of the at least one matched point corresponds to the measured point;

d. a map route processor coupled with said correlator and said map database, said map route processor calculating at least one statistical parameter from a deviation distance between said at least one measured point and said at least one matched point to determine the map route from a plurality of candidate routes,

said map route processor calculating a correlation characteristic for said at least on statistical parameter and confirms a map route from said plurality of candidate routes using said correlation characteristic,

said map route processor identifying the map route from the candidate routes and the map route has a correlation characteristic within a preselected range; and

e. an analyzer coupled with said correlator and said map route processor to detect an end of a curve in the map route and update the measured point and the matched point to the end of the curve.